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Master's Thesis

Academic Year 2013

An Efficient Tele-Collaborative Video Production Environment on SAGE

Graduate School of Media Design

Keio University

Ryohei Ohki

A Master's Thesis

submitted to Graduate School of Media Design, Keio University

in partial fulfillment of the requirements for the degree of

MASTER of Media Design

Ryohei Ohki

Thesis Committee:

Professor Naohisa Ohta (Supervisor)

Professor Akira Kato (Co-Supervisor)

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Abstract of Master's Thesis of Academic Year 2013

An Efficient Tele-Collaborative Video Production Environment on SAGE

Summary

With the advancement of digital technology, video production can now be undertaken in a remote collaborative environment. Many tools have been created in the past to enhance such environment, but none of them have succeeded in connecting "spaces" to enable users to interact creatively and intuitively. The research in this thesis attempts to create an environment where traditional creative collaborative work can be practiced with a remote location. Scalable Adaptive Graphics Environment (SAGE) was chosen for the platform of this environment, and was used in the production of a collaborative documentary with UCSD as a preliminary test. The features necessary for SAGE to become an efficient tele-collaborative video production environment are derived from observations and user interviews. Taking these data, this action research thesis describes the proposed implementation of new functions for SAGE by categorizing them into the affecting key factors in remote collaborative video production, along with a new workflow using the new functions. An user test is conducted to see the effectiveness of the playlist output function, which was successively implemented as a first step. User interviews are conducted to evaluate the effectiveness and difficulties of the overall proposed implementation. Finally, the conclusion examines the possibility awaiting in the future for SAGE.

Keywords:

Video Production, CSCW, Tele-Collaboration, Collaborative Workspace, SAGE

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Table of Contents

List of Figures

List of Tables

1. Introduction

1.1 Background

With the advancement in computer and network technology, production of media contents have now become possible without the necessity of people gathering at the same location every time, and professionals spread around the world can now communicate with each other in real-time to work on a project together in a remote collaborative form. Video production is an area that can enjoy many benefits from this environment, not just because of the high number of roles necessary, such as producers, investors, creative talents, and technical personnel, but also since it is usual that even short productions, like a sixty second commercial, are international productions with people involved from locations scattered all over the world [1]. Also, the data size of a video file is much larger than other media files, additionally showing how video production enjoys the benefits of recent technology developments.

Project work has been part of video production since at least the 1950s [2], and collaboration between individuals with different roles has been the standard of film production for more than sixty years. Then came the digital movement, where by the early 1990s, computer-based non-linear editing systems were introduced and within a few short years dominated post-production [3].

Although digital technology dramatically changed conveniency and cost, the basic workflow of video production has stayed the same. By 2000, even though feature films were using electronic edit systems, virtually all motion pictures also continued to screen film “dailies”, rough edits readied for viewing by creative filmmakers and studio as well as editing.

Regardless of fictional or documentary, this is the basic workflow of video production, and in order to maintain it when people from multiple locations are participating in a production, remote collaboration technologies need to enable the following three activities: electronic delivery, accessing resources and materials, and joint real-time remote decision-making [4].

There have been multiple softwares and experimental prototypes created in the past with the aim to achieve these goals. As softwares, they may be convenient for users to acquire, but most of them focus only on a singular aspect of the whole process involved in remote collaborative video production. Acknowledging this situation, Adobe and Sony, major companies of the media industry, are now in progress of creating a platform to cover the whole process. All of these efforts made are definitely contributing to make a remote collaborative video production environment better, but since they are softwares meant to be used on a PC, users are restricted to do their work in front of a screen with a keyboard and a mouse.

"Electronic delivery" and "access to resources and materials" might be made possible by these softwares, but there is much more effort that can be done for "joint real-time remote decision-making". Much more creative discussions and work can be made when people are together in the same space, where all body language and facial expressions can be noticed. For a more efficient environment, the users should feel as though they are sharing the same space with the remote team, intuitively interacting with each other to work together.

On December 12, 2012, Walt Disney Studios opened Disney Digital Studio Services[1], a new team of Walt Disney Studios focused on the future to "help our colleagues and filmmakers master the challenges and complexities of today's digital production, post production, marketing and distribution workflows". The digital file-based workflow hub occupies approximately 8,000 square feet of space on the Ground Floor, aimed to "prepare files for all phases of the Walt Disney Studio's content life-cycle, as well as house a new

modern home for our filmmakers and their new increasingly integrated and collaborative creative editorial and finishing workflows".

Disney Digital Studio Services recognizes how filmmaking has become global and how members involved in a film production are spread out in locations. However, as they are professionals, they understand that there are situations where "one literally needs to be in multiple places at once to finish the film." The studio aims to accomplish this seemingly impossible task by defining and designing the ability to talk to, look at, and create with multiple global creative collaborators in one place. Their Global Collaboration Theater aims to re-define how work with partners, vendors and creative staff can take place over secure high-speed, high-quality, network connections that will allow team members around the world to "transport themselves into one virtual room".

1.2 Research Aim / Thesis Goal

The gigantic space that Walt Disney Studios has created is definitely an environment that enhances remote collaborative film production and should be highly appreciated by professionals; however, ONLY professionals that would have the access to it.

The author has conducted research for establishing such environment that enhances the productivity of a remote collaborative video production, where "spaces" are connected and people can interact more creatively WITHOUT restricting people by social status, technical abilities or geographical location. To accomplish this, SAGE (Scalable Adaptive Graphics Environment)[2], a graphics streaming architecture created by the Electronic Visualization Laboratory, University of Illinois, was implemented to act as the base platform. Although initially made for scientific visualization, SAGE has tremendous potentiality for being used in video production and can be expanded in many ways, which will be further

discussed in the later chapters. After conducting a preliminary test using SAGE, where students from the Graduate School of Media Design, Keio University (KMD)[3] and University of California, San Diego (UCSD)[4] collaborated to create a documentary, many observations were made that to make SAGE a better tool and platform for a remote collaborative video production environment.

From the observations collected from related works and the preliminary test, this paper proposes functions for SAGE to facilitate a more efficient tele-collaborative video production workflow. It will go through what kind of functions would be necessary to establish such environment, and the workflow that becomes possible from the implementation of them.

1.3 Thesis Overview

Chapter 1 has introduced the background and aim of this thesis. Chapter 2 will go over related academic and commercial works in the field of collaborative video production. Chapter 3 will describe the preliminary test conducted and go through the observation made during it, leading to Chapter 4 that will describe the proposed implementation of the functions and workflow necessary to make SAGE an efficient environment for tele-collaborative video production. Chapter 5 will evaluate this environment by conducting interviews with key people. Finally, Chapter 6 will wrap up this paper and also refer to future works to see how this research can continue on.

Notes

[1] http://disneydigitalstudio.com/

[2] http://www.sagecommons.org/

[3] http://www.evl.uic.edu/

[4] http://www.ucsd.edu/

2. Literature Review / Related Works

2.1 Video Production Workflow

In order to create an efficient environment for remote video production, it is essential to look through the core elements involved in the workflow of video production, and what would be necessary on top of it when the production involves people participating from different locations.

2.1.1 Traditional Video Production Workflow

Whether the work is a Hollywood movie or an indie documentary, video production generally involves three key phases: pre-production, production and post-production [5]. Pre-production describes the period before the actual filming starts, during which producers make the major financial and creative decisions, including the selection of script, cast, crew and locations. Production encompasses the actual filming, both “on location” and at studio-type premises. Post-production involves the compilation and editing of the filmed material. This involves the production of special and visual effects sequences and compositing - the combination of a number of different media elements, such as computer graphics or animation effects - with live footage (Figure 2.1).

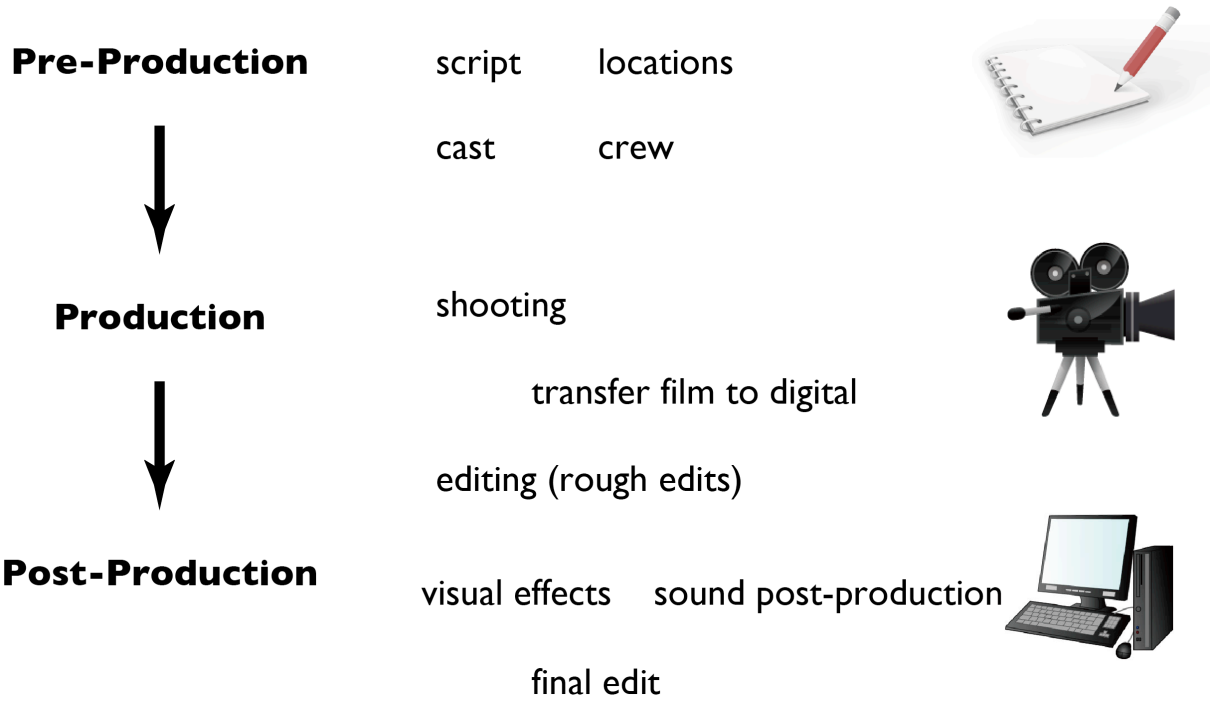

Figure 2.1: Basic workflow of video production

The three key phrases all require different abilities, which shows the dynamism and amount of collaboration involved in film production; where pre-production would require more of business and management skills, post-production is carried out by people with specialities, e.g. editing skills and computer graphics skills. Needless to say, not just the three key phases being a collaboration of people with different kinds of abilities, collaborative work take place within each phase itself, e.g. a director discussing with an editor about how to sequence the footage during post-production.

2.1.2 Workflow with Remote Environment

It was not until the 1990s that remote collaboration took on an important role in organizing film production. Remote collaboration within film production can occur at any stage: within pre-production (e.g. joint decisions on casting, selecting locations), production

(e.g. transmitting dailies or rushes from production sites to decision-makers, coordinating animation work), post-production (approving of editing and special effects work), or related publicity (trailers, advertisements) (Figure 2.2).

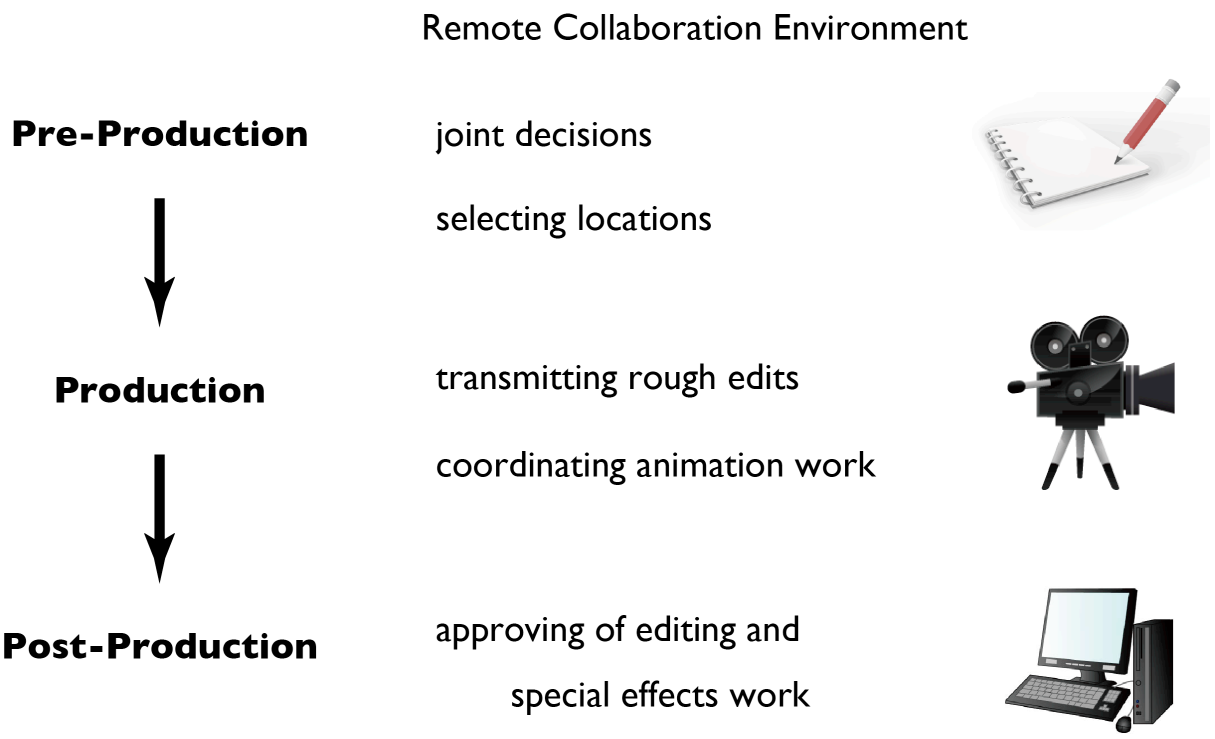

Figure 2.2: Workflow for remote collaborative actions taken in video production

As an example from Hollywood, Steven Spielberg used remote decision making during the post-production of *Jurassic Park* in California while he was in Krakow shooting *Schindler's List*. [6]. After finishing the shooting of *Jurassic Park* twelve days ahead of schedule, Spielberg went on to the production of *Schindler's List*, where he monitored the progress of the post-production for *Jurassic Park* from Poland via satellite. The satellite transmission was scrambled on both ends for security reasons, and Spielberg would get a picture of the remote side, where they would run the film to go over with Spielberg and make changes. The film score was also transmitted to Spielberg over the DAT (digital audio tape)

dish, where he would get to listen to the music through large speakers in real-time, making him feel as though he was at the scoring session.

Devin Ohara, who participated as a director in the production of the later described collaborative documentary "Places + Perspectives", broke down the six affecting factors in remote collaborative filmmaking: discussion hub, contents evaluation, common shared data, rough editing, refined editing, distribution and expansion (Figure 2.3) [7].

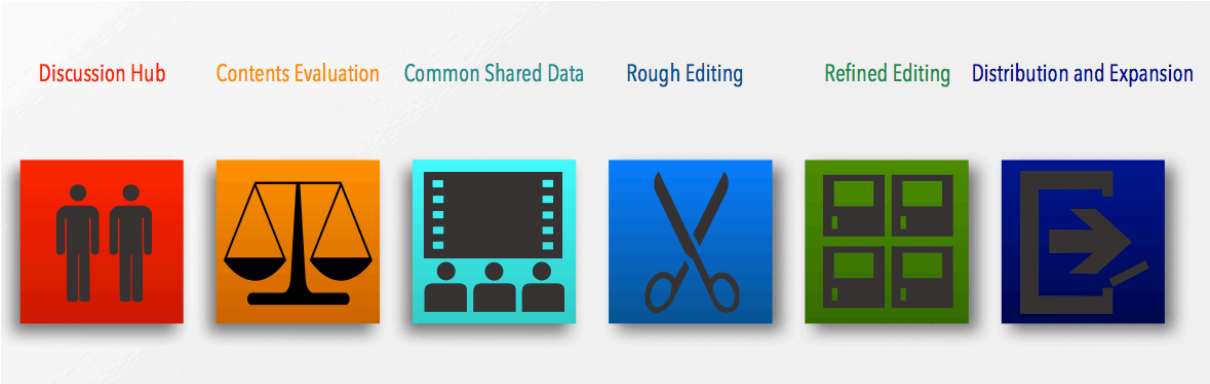

Figure 2.3: Ohara (2012) Six affecting factors in remote collaborative filmmaking

These might seem nothing special since they are the basic actions taken in any video production, where collaborators would discuss with each other on the contents with rough edits and make efforts to achieve a refined final work that would later be distributed to the public. However, Ohara's main point is how difficult it is to smoothly execute the work included in these factors with a remote environment. Even the discussion hub, which might seem easy with today's technology like Skype or Polycom, is actually very difficult to accomplish flawlessly. Ohara states "even when connected to the fastest wireless network, the lag in the audio and visual information did not allow for effective debate on issues". The discussion hub "must have not only an open space where members are allowed to make text posts and carry on conversations and share ideas", but it is also must be an environment for

ideation. Tools that would be used in a discussion of a standard video production, from a normal pen and paper to screens and monitors for sharing videos, are not installed in these communication systems and does not make them an effective ideation environment.

Important parts of our professional and personal life still depend on co-located collaboration and face-to-face communication, and rely on physical and social benefits of using surfaces such as tables and walls to exchange and visualize different types of information [8]. The ideal environment for a remote collaborative environment would be one where the users can interact with each other as though the are sharing the same space.

2.1.3 The Importance of Editing

In his paper, Ohara reflects the time and effort especially spent for editing; “After the internal brainstorming post-production sessions, each team would take turns showing off their respective editing. After going through seven rounds of ideation, the edits were continuing to grow further apart from each other, almost as if it was not collaborative filmmaking, but competitive filmmaking using the same contents”.

“Places + Perspectives” is a documentary, where unforeseen events and interviews can arise that would lead to outcomes far different from what could have been planned. As Quitemeyer puts in the figure below, documentaries often face unforeseen changes in their content units (marked “c” in the Figure 2.4) [9].

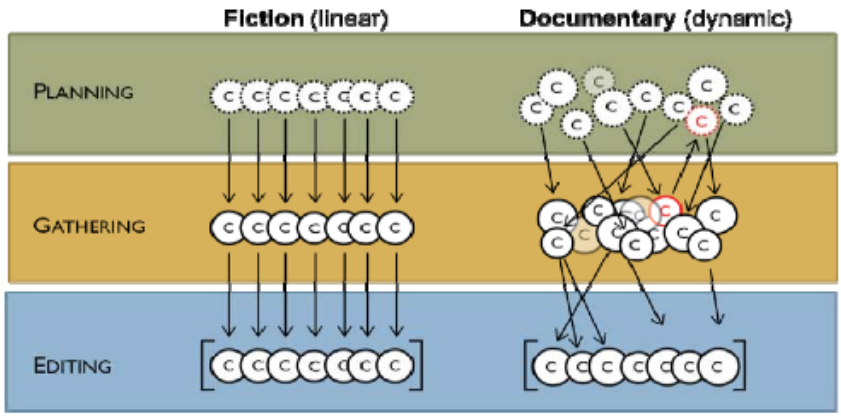

Figure 2.4: Quitemeyer (2012) Differing content management in fiction and documentary video production

Because of this, documentary productions might seem more likely to rely on the editing process compared to fictional work, since unexpected contents arise and plans transform along with them. However, even in a fictional movie production, where a storyboard is already planned before shooting, editing equally becomes a key factor. Although editing is usually categorized as part of post-production, "regardless of technology or terminology, post-production usually does not begin "after production" but more accurately is concurrent with production", where the production team will check rough edits to see how the contents they have so far.

Moreover, although most fictional work do have completed storyboards ready beforehand, there are situations where unexpected events occur during the production of them, just like when shooting documentaries. When the author of this paper participated in the production of a short movie as an assistant director, an unexpected typhoon struck on the shooting day. Because of the schedules of the cast and staff members and the booking of the location, the shooting date was unmovable. Acknowledging this situation, the director made a decision to amend the script at the spot to actually utilize this event, changing lines and shot angles to make use of the unfortunate weather to act as a dramatic effect in the story.

Since unexpected events that lead to unexpected changes on a storyboard can occur in a production of a fictional story too, the editing process is equally important to all types of video productions, where rough edits are used during discussions to see how different shots integrate with each other and how the story progresses.

This was the same for the production of “Places + Perspectives”, where visual storyboarding was done during meetings, leading the team to frequently create rough edits as the production was still in process.

Silverman also talks about digital cinema, where digital projection technology has made it possible for “high-definition dailies (rough edits) to be screened on location and in screening rooms as part of the new motion picture post production process that results in a digital preview master”. Compared to the old days where rough edits had to be created manually on a film, digital technology has magnificently reduced the cost for previewing rough edits, leading to the rise in reference and reliability of the already important process of film production.

For an effective tele-collaborative video production environment, users from multiple locations should be able to smoothly communicate with each other and go through contents to create rough edits and evaluate them. The accumulation of this leads to the creation of a refined edit, which means the more users can be comfortable and creative to undergo these processes, the better the final outcome would become.

2.2 Related Works

Related works are gone over to see what kind of common features they have, and to see what aspects of video production they focus on.

2.2.1 Academic Works

Many prototypes have been created in the academic field to raise the productivity of remote collaborative film production. Take for example StoryCrate, a tangible, tabletop interactive display system designed to facilitate collaborative production in a broadcast scenario. The interface of the system is based on a multi-track video editor that presents all footage on the display and allows users to see and make links between all available clips, and it "uses a storyboard to present a single point of reference for the entire crew, enabling a greater awareness of current progress, facilitating creativity and ownership of content within the team and driving decisions made on site directly into the current digital workflow" [10].

In contrast to StoryCrate, where the main focus is to have a storyboard for all users to share, FilmEd, created by the University of Queensland, Australia, focuses on indexing and annotation. With the acknowledgment that "previous video annotation systems have not been collaborative, real-time, synchronous systems capable of supporting high quality MPEG-2 content", the system enables "collaborative online discussions about particular film or video content and real-time annotation of segments, key frames or regions within keyframes between distributed groups" [11].

DiVA, developed at the University of Applied Sciences Osnabrück, is a collaboration tool also focused on text and graphic annotations for videos. It takes a client-server based system approach, allowing several users to join a session concurrently, and "For each meeting not only the audio communication is recorded and can be replayed later but also the actual position of video playback during the discussion is stored".

These tools are useful, but the problem is the fact that they only focus on a partial aspect of the whole process involved in video production.

2.2.2 Commercial Works

On the market, there are two softwares currently under production as of this writing by big names of the media industry.

Adobe Systems launched the collaborative workflow platform “Adobe Anywhere” at NAB 2013. “Adobe Anywhere is unique with its open platform architecture that includes use of existing infrastructure and integration with standard IT hardware, software, and network processes, thus reducing the need for additional capital expenditure and resources. Adobe Anywhere does not require heavy file transfers and does not rely on proxy files, enabling video professional to work directly with high-quality media. For complete control and security, Adobe Anywhere is hosted on-premise with other enterprise media storage and asset management infrastructure.”

The biggest advantage is having features tied with Adobe Premiere, one of the most used NLE software by professionals. Project files of Adobe Premiere can be shared with other users as a pack, enabling access to timelines and workspaces for all users. Think of Microsoft SkyDrive and how Microsoft updated their text editing environment, where before users had to save and send to each other Word files every time changes were made, while now files are saved on the cloud and multiple users can work on the same file in a real-time and synchronized form [12]. Some of the features and merits of Adobe Anywhere are shown in Figure 2.5.

Adobe Anywhere is still under production and is scheduled to be released during the year of 2013.

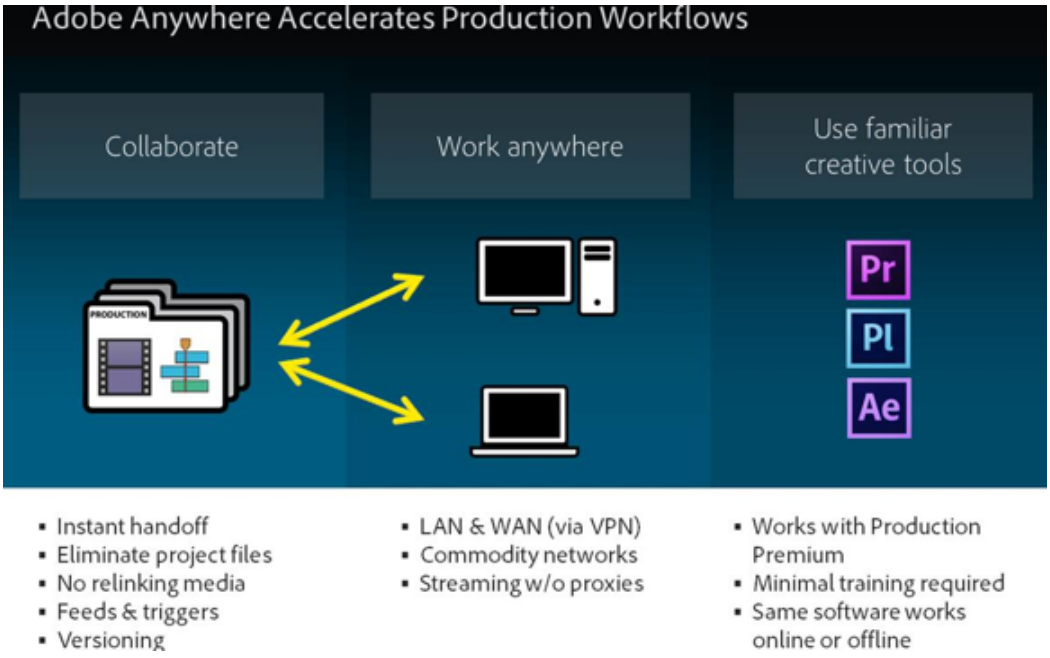

Figure 2.5: Grotticelli (2013) Workflow for Adobe Anywhere[1]

Sony also announced the launch of a cloud-based platform on April, 2013[2]. Being very similar to Adobe Anywhere, Sony's platform "Sony Ci" includes a number of applications that are designed to work in conjunction with one another and give production studios, broadcasters, marketing teams and the like a one-stop solution for finding, producing and archiving high-quality content [13],

The platform is planned to include:

- Ci MediaBox: Collects, organizes, previews, shares and archives every media type and size using studio-designed cloud storage solution suite
- Ci VideoLog: Enables logging of frame-accurate events to prepare content for downstream opportunities, distribution and playout automation
- Ci AudioSync: Utilizes analysis algorithms and audio pattern matching to reduce non-creative editing work time in content-preparation workflows
- Ci FrameMatch: Analyzes media files to automatically identify differences and likenesses between two sets of video files

- Ci ReviewApprove: Enables review, annotation and collaboration on media files across multiple locations in real time, simultaneously

Although not having a firm connection with a NLE software like Adobe, Sony takes a similar approach by preparing a platform to manage the whole complex workflow of modern film production by including multiple applications that cover different stages and operations involved. The screen shot from it is shown in Figure 2.6.

Sony Ci is in beta production as of this writing and is available within the U.S. and European markets, with plans for additional service capabilities to be launched within the year 2013.

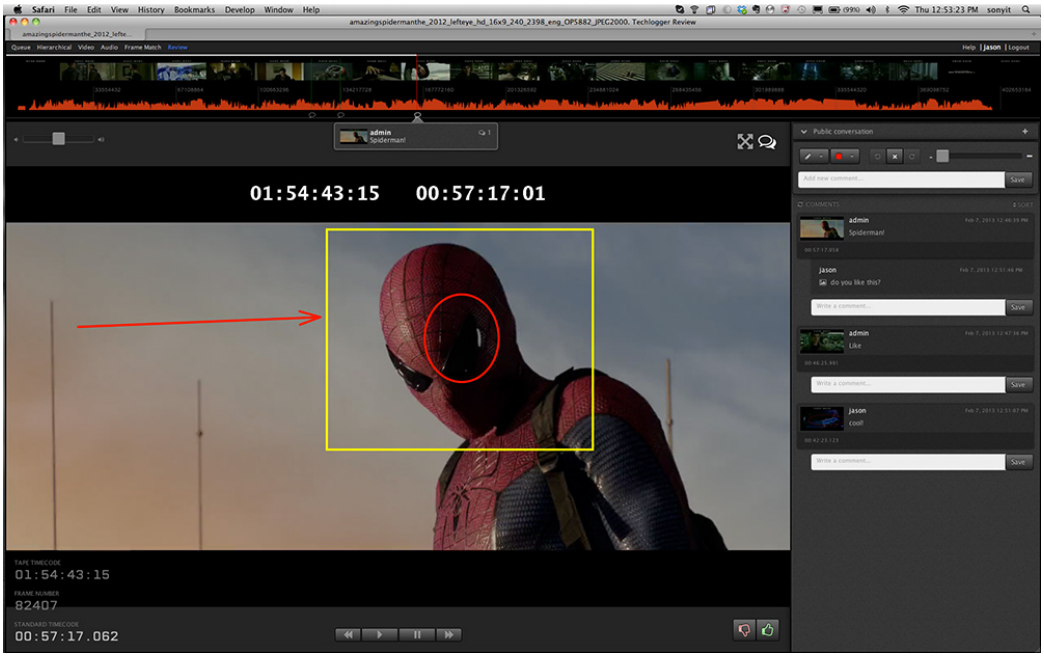

Figure 2.6: Screenshot of Sony Ci Software[3]

2.3 Analyzation

The related works all have unique characteristics and individually show their own take on trying to create a more productive environment, but they are all similar in the way of

how they try to make information sharing with other members easier during a tele-collaborative video production. The three activities stated by Palmer that are enabled by remote collaboration technologies (electronic delivery, accessing resources and materials, and joint real-time remote decision-making) can all be rephrased as information sharing (i.e. network transfer allowing files to be delivered in multiple locations to share files, a server for users to share resources and materials, a system for users to debate and share information real-time), and the related works raised in this chapter all aim to accomplish this.

StoryCrate tries to complete this goal by focusing on the storyboarding stage. With a member of BBC Research & Development included in the development team, the system is designed to be used in a broadcast scenario, where time and pressure to produce new and creative content is very high, and it aims to support creative decision-making by pushing the point at which a number of creative decisions are made earlier in the workflow.

As it is apparent from the title of the system, the team of StoryCrate recognizes the value of storyboarding in video production. “Big budget productions such as Hollywood blockbusters use storyboards to plan high-risk sequences and special effects to reduce re-shoot costs and manage risk”. “We therefore chose to reproduce and revise the storyboard in digital form, as a dynamic shared representation for collaborative use by members of the production team during film shoots. As an external representation it aims to allow any team member to have access to shoot progress and to understand their own role in relation to it”.

By enabling real-time collaborative indexing, browsing, description, annotation and discussion of high quality digital film or video content, FilmEd considers more of a situation where multiple users are going over footage already taken. Where StoryCrate contributes in keeping everyone on the same page AT THE MOMENT by sharing a visual storyboard, a system like FilmEd is essential when going over ideas and decisions made in PAST meetings.

DiVA, in terms of philosophy, tries to take in the good sides of both of these two softwares. The creators listed up the minimum requirements for the system to make it effective in a post-production of a remote collaborative environment; synchronized navigation and a common video screen, graphic and text annotation, multi user approach, archiving of annotations, categorized annotation, high-quality video material, story board development, and video content processing.

At the moment, the main function of DiVA is text and graphic annotations, and it is unclear how much the system has been updated today, but the vision they hold for achieving an effective environment for remote collaborative film production is definitely accurate.

Combining the use of these softwares might be one solution to undertake remote collaborative video production smoothly, but as a student from the preliminary test states, when so many different platforms are used at the same time, it is difficult to stay on top of all the information. This is why the philosophy of DiVA and the platforms by Adobe and Sony, aiming to cover the whole production in one system, becomes attractive by having all information stored on the same platform.

There are many advantages for managing the whole production with a single platform. For example, information transmission between softwares that are part of the platform would not be an issue. Adobe and Sony's products, which are still under development and specific details of each of them are not yet open at this time, have multiple softwares included in the platform and most likely they are designed to work smoothly with each other, making data transmission between them effortless, just like how an editor can integrate data created on Adobe After Effects on to Adobe Premiere. This is a crucial factor, since the lack of interactivity between the systems become disappointment for users and can lead to reduction in productivity.

It is no doubt ideal for a remote collaborative video production environment to have all information stored on the same platform for all users to view, edit, and share. The key is to have functions on the platform so that users from different locations can use the information creatively during a work in real-time (e.g. storyboarding), and also have functions that enable them to look back at records to review discussions from before and see where the production is heading (e.g. logs, annotations). On top of this, the environment should not restrict users to sit in front of computers, and instead give the freedom of interacting creatively to work on a production.

Collaborative creative work is done best in co-located settings. In order to keep the creativity of the people at a high level, even in a remote collaborative environment, users should be able to interact as though they are sharing a space.

When people are in the same space, they tend to rely on traditional creative methods, such as using a whiteboard to share and keep track of information with multiple people. These traditional methods are valuable, as Palmer, Dunford, Rura-Polley and Baker conducted a research that proved "rather than changing and replacing "old" organizational practices with new practices, the complexity of the hyper-competitive environment appears to require their mutual co-existence". The valuableness of traditional methods can also be seen from the fact that the basic workflow of video production has not changed, even after the dramatic change that arose from digitalization.

The goal of the author is to create an environment where users located in multiple locations can communicate with each other for discussions, ideations, and collaboration using traditional creative methods, and fulfill the functions that are necessary for video production, which has yet been done in the past. The environment should cover the features explained before in this chapter and should enable users to act as though they are sharing spaces.

Notes

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[1] Grotticelli, M. "Adobe Anywhere offers broadcasters a collaborative workflow for news crews working anywhere" http://broadcastengineering.com/remoteob/adobe-anywhere-offers-broadcasters-collaborative-workflow-news-crews-working-anywhere

[2] "Sony unveils new Media Cloud Services subsidiary alongside Ci, a collaboration platform for creatives" http://thenextweb.com/insider/2013/04/03/sony-unveils-new-media-cloud-services-company-and-ci-a-new-collaboration-platform-for-creatives/

[3] Kaufman, D. "Sony Launches Media Cloud Service Company" http://library.creativecow.net/kaufman_debra/Sony-Media-Cloud-Services/1

3. Facilitating an Efficient Tele-Collaboration Environment

3.1 Platform Comparisons

An efficient platform was needed to be chosen in order accomplish the author's goal to construct an environment for tele-collaborative video production that would allow users to communicate with each other for discussions, ideations, and collaboration using traditional creative methods as though they are in a co-located setting.

3.1.1 SAGE and Other Platforms

A comparison would made to see which platform would work best.

A research team from the Hasso Plattner Institute of Potsdam, Germany created TeleBoard[1], a system which combines video conferencing with a synchronous transparent whiteboard overlay [14]. Approaching from a philosophy of how collaborative creative work is done best in co-located settings, the electronic whiteboard software suite allows users to write digital sticky notes on Tablet PCs, smart-phones, or directly on a whiteboard. The sticky notes can be resized and the color can be changed, which are synchronized automatically and propagated to every connected whiteboard client. The setup lets everyone see what the other participants are doing and where they are pointing at, and users can see the gestures and facial expressions of each other, enabling them to work together as though they are in the same room (Figure 3.1).

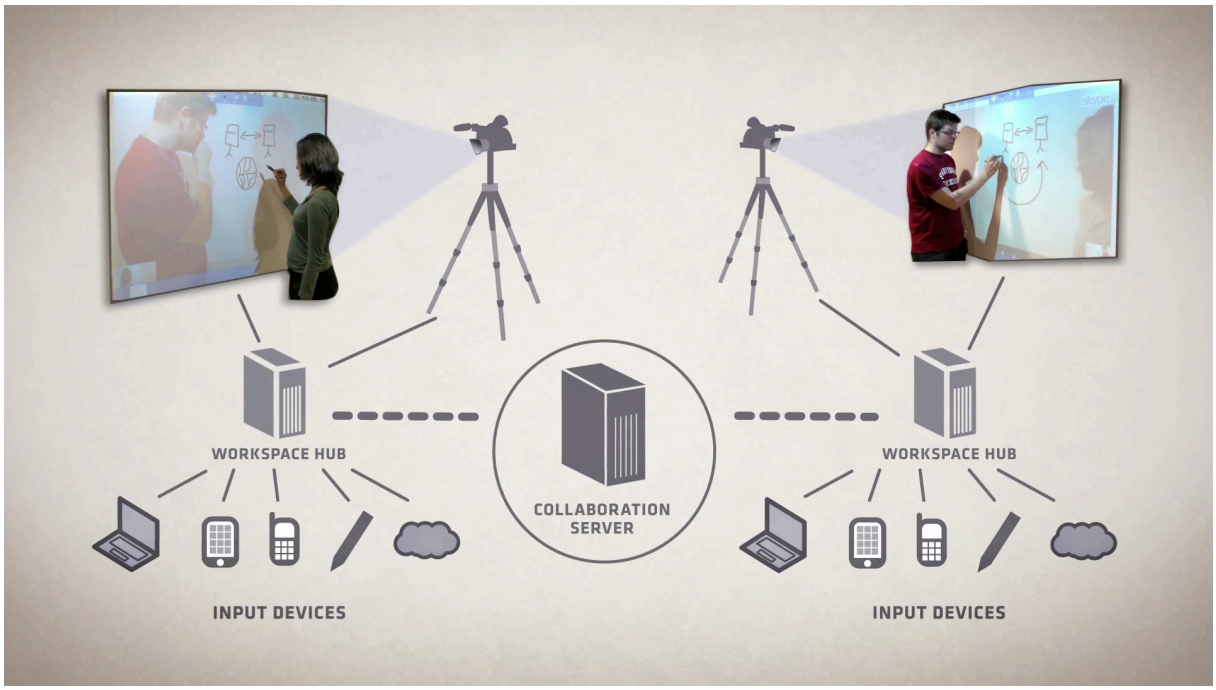

Figure 3.1: Setup of the Tele-Board

Tele-Board is excellent in terms of connecting "spaces", bringing the traditional collaborative creative method of whiteboard into a virtual workspace. However, video production involves much more complex work as seen in the preceding chapter and all of the work can not be fully covered by a whiteboard.

Information visualization company Oblong Industries, known for providing the visual computing in the movie *Minority Report*, has created a collaborative conference room called Mezzanine[2]. It is a multi-user, multi-screen, multi-device collaboration system, allowing users to share any content from any device with anyone, anywhere [15].

Figure 3.2: Mezzanine being used in a business meeting

As it is a product sold on the market, the quality of Mezzanine is very high with a sophisticated interface and a firm system. The system is targeted to be used in conference rooms for meetings, which can be seen from Figure 3.2.

An environment like Mezzanine would be highly appreciated by many people. However, the fact that Mezzanine is highly established as a product also means it loses freedom of being customized to cover the workflow of video production, and wouldn't make it a suitable platform for remote collaborative video production.

The University of Illinois at Chicago (UIC) Electronic Visualization Laboratory (EVL) created SAGE, a cross-platform, open-source middleware that enables users worldwide to have a common operating environment, or framework, to access, stream and juxtapose data objects — whether digital cinema animations, high-resolution images, high-definition video-teleconferencing, presentation slides, documents, spreadsheets or laptop screens — on one or more tiled display walls (Figure 3.3).

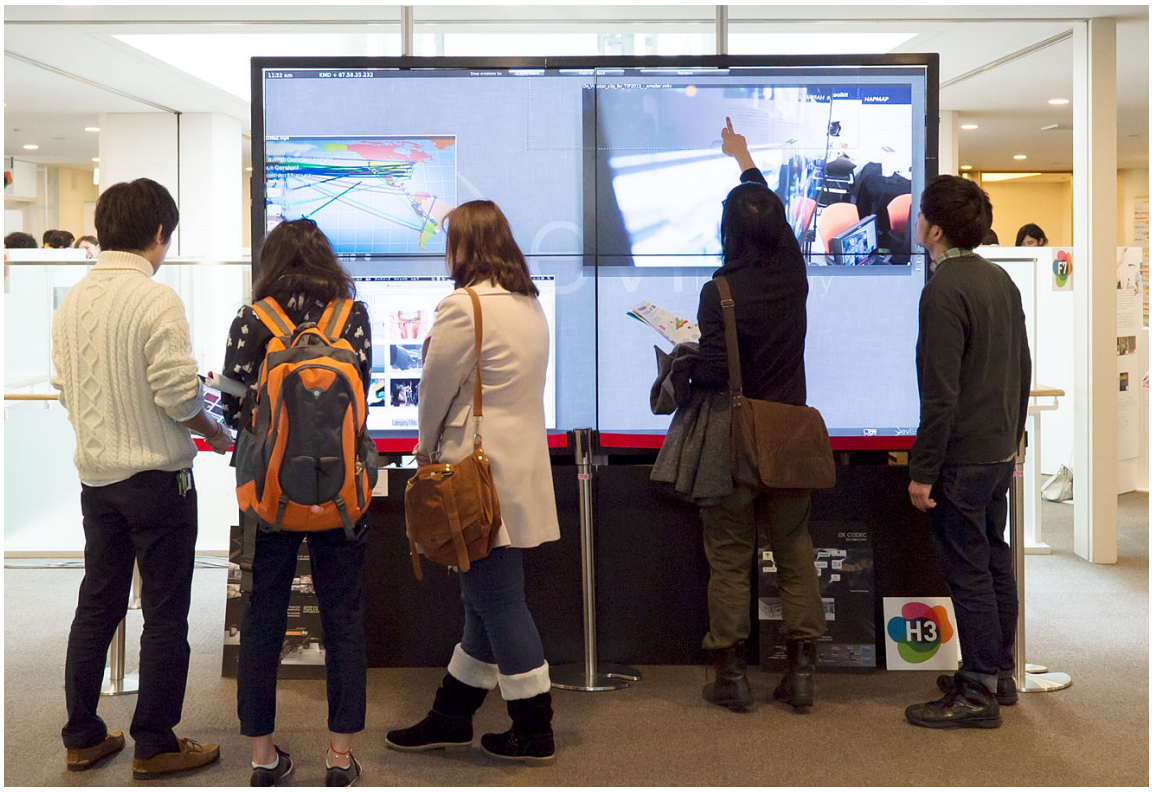

Figure 3.3: Using touch sensor to move video files around on SAGE

As a vision, the creators of SAGE assumes that displays will be cheap enough to "wallpaper" entire rooms, and that the bandwidth needed to drive them will become even cheaper. Future situation rooms and research laboratories will have walls made of seamless ultra-high-resolution displays fed by data streamed over optical networks from distantly located visualization clusters, storage servers, and high-definition video cameras.

First, SAGE is able to share high resolution video files within a local environment AND with a remote environment. It adapts to the space available, making it beneficial for different types of users and different types of spaces. Physical space can be used effectively because of this, where people can gather around SAGE to discuss about contents instead of people gathering around a small PC monitor or people individually using synched softwares.

Also, since it is an open platform, users around the world can contribute in the development of SAGE, spreading the possibilities and raising the productivity when adding on functions.

For all these reasons, SAGE was chosen for the base platform.

3.1.2 Choosing SAGE

SAGE is completely free source and is downloadable by anyone via the internet. The characteristics of this free tool can be utilized to make it an efficient platform for a remote collaborative environment.

SAGE becomes a powerful tool for visual storyboarding. Further discussed in this chapter, SAGE enables users to display, resize, and relocate video assets on the screen (hereon referred to as 'SAGE Wall'), and share them with a remote SAGE client. The SAGE setup in KMD has touch sensor frames placed around it, which is not a requirement but becomes a intuitive and useful interface for building storyboards. Storyboarding is an essential work during video production that leads to creation of rough edits, which are then brought to meetings to have deep discussions based on them. Regardless of local or with a remote location, people can gather around SAGE to discuss about the contents.

As the name of the system explains, SAGE is scalable and adaptive, so the number of screens can be increased at anytime by the user's will, making it adaptive to any space. It can be used in a gigantic space like Disney Digital Studio or just on a normal 16:9 screen for a PC. The screen can be anything as long as it is connectable with the computer running SAGE. For the SAGE setup in KMD, 4 HD monitors were installed.

Users can connect their computers to SAGE by using the "SAGE Pointer" application. After connecting with SAGE by simply inputting the IP address of SAGE on the

same network, the mouse cursor of the computer can become a cursor on SAGE, enabling users to control media assets displayed on the SAGE Wall even from a distance. SAGE Pointer allows you to upload media files that are saved in a user's computer. An additional feature of the SAGE Pointer is the "Share Desktop" function, which enables users to mirror their desktop screens on to the SAGE Wall. This way, information format that SAGE is presently not compatible with (e.g. information on websites) can be shown by displaying them on the user's computer, which gets mirrored on to the SAGE Wall, as shown in Figure 3.4.

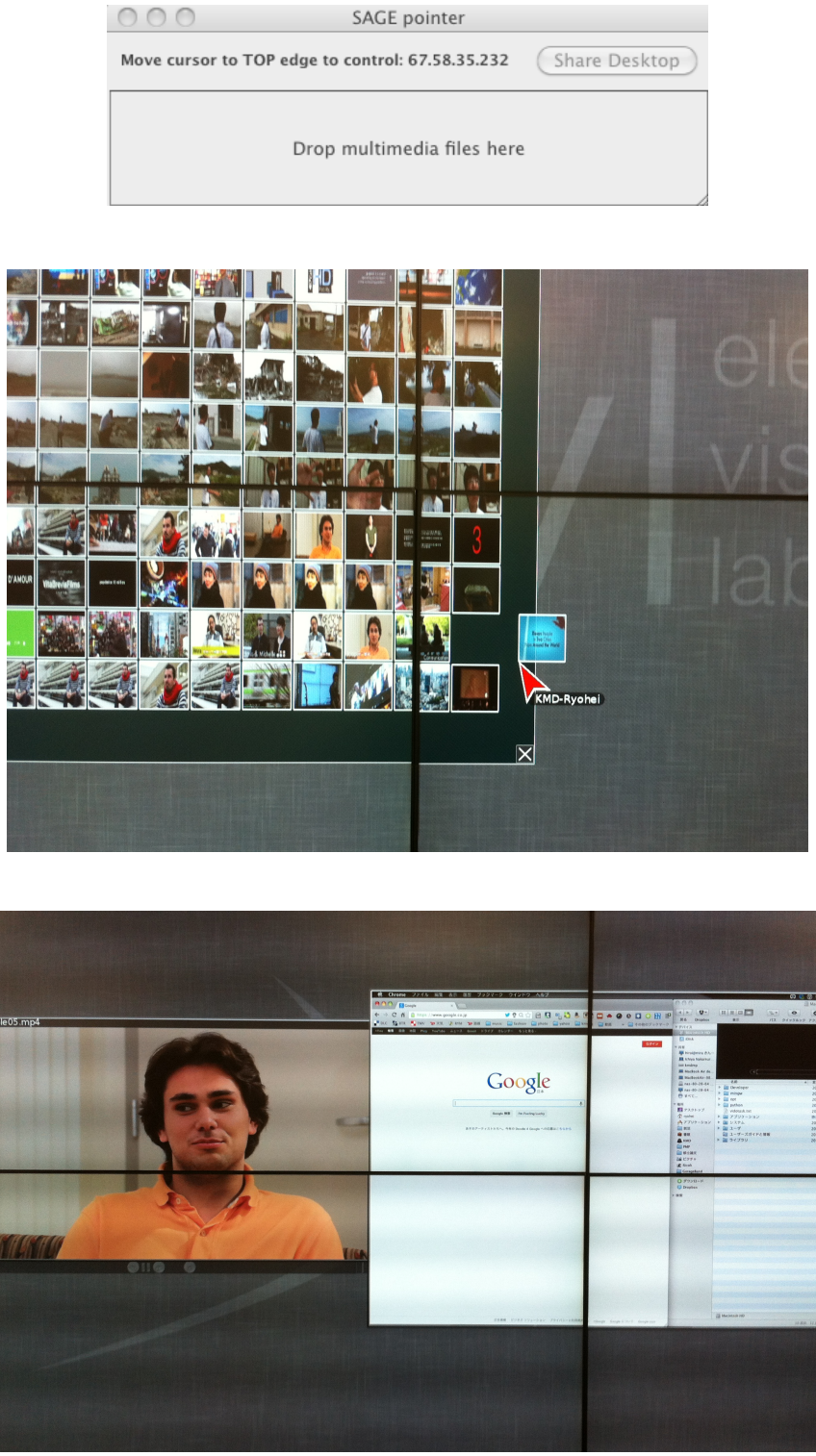

Figure 3.4: Screenshot of SAGE Pointer, mouse cursor, and desktop sharing using SAGE Pointer shown on SAGE Wall

SAGE already has a “send file” function, which sends media files to a designated SAGE client on the same network. At this point, only one client can be connected at a time, restricting the range of collaboration that can take place and the possibilities that it can have.

Another feature of SAGE is the “save/load session” function, where media files displayed on the SAGE Wall can be saved as sessions. Loading them will display the files at the locations they were saved at.

The main features of SAGE are summarized in the following Figure 3.5.

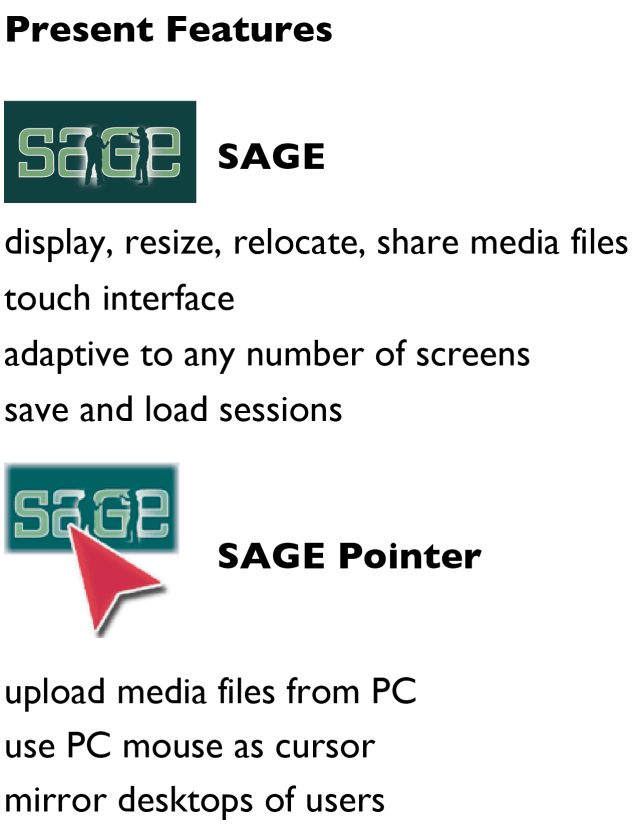

Figure 3.5: Present features of SAGE

The features presently integrated on SAGE are not enough for enhancing deep contents evaluation / joint real-time remote decision making to take place. As stated before, SAGE was initially made for scientific visualization and did not consider the complex works

carried out in video production. Visual storyboarding is a good first step, but more would be necessary for users to evaluate the contents.

Although it might not be enough to be used in a major production with the stage it is in right now, SAGE has the potential to cover all six affecting factors that Ohara derived from his research. To find the missing pieces that need to be filled in, a preliminary test was conducted to see what kind of functions would users find necessary when they use SAGE in an actual production.

3.2 Preliminary Test

As a preliminary test, students from the PMP project of KMD and the University of California, San Diego (UCSD) used SAGE for the production of a collaborative documentary, which took place from November, 2011 to August, 2012. The preliminary test was conducted to see how SAGE would be used in an actual production, and what kind of opinions users would have when using it.

Collaboration was made from the brainstorming process, where the students from both sides repeated meetings to decide on a theme and concept for the documentary. Despite the time difference between Tokyo and San Diego, the two teams managed the schedule well to repeat meetings and came up with the theme of “displacement”.

Once the theme was established, both parties went on to shooting interviews and sceneries. Whenever either side had new footage to share, they were shared instantly through SAGE. The two teams would then display the video files on the SAGE Wall during meetings and move them around to come up with an order (timeline) that is most suitable for conveying a story.

3.2.1 Setup

The setup of SAGE in the campus of KMD included 4 HD monitors, making up a total resolution of 4K (3840 pixels x 2160 pixels). Compared to the minimal yet sufficient space of KMD, UCSD's V-room, an augmented environment for remote collaboration, had 56 monitors in total for SAGE, which was more than enough for the UCSD team (Figure 3.6). The two rooms were connected with a 10-gigabit ethernet network (CineGrid Network), making the sharing process of sending media files to each other completed in seconds.

Both sides setup 4K cameras and an audio system to send and receive the visual and audio of each other. The image taken by the 4K cameras were connected into NTT JPEG2K encoder units and were transferred on the CineGrid Newtork, which would be decoded by the NTT JPEG2K decoder units of both sides to receive the image of the opposite side in real-time. The audio signals from both sides were embedded on the image data, which would get disembedded to get connected to a speaker system, as shown in Figure 3.7.

Figure 3.6: SAGE Walls implemented in V-Room, UCSD

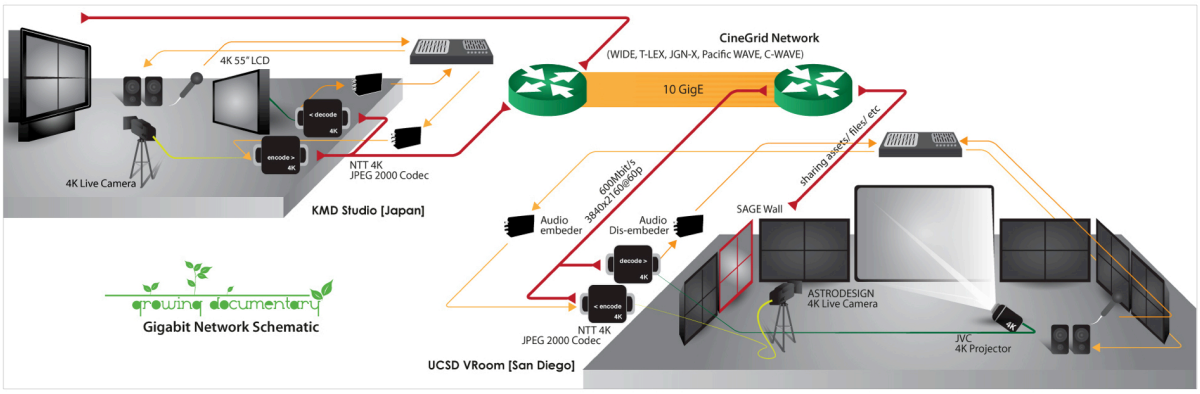

Figure 3.7: KMD and UCSD remote meeting set up

The accumulation of this real-time footage sharing process ended up as a 15 minute long documentary entitled “Places + Perspectives” [3].

3.2.2 Observations

The production of “Places + Perspectives” revealed the crucial factors in remote collaborative video production, and the elements that SAGE would need to focus on to make it an effective platform.

In a scene of remote collaborative video production, multiple locations are connected with each other to share data and ideas, and the management of them is a key factor to make the production work out well. In the production of “Places + Perspectives”, where two locations were involved, a cloud server was set for both sides to keep contents in a same location, but there were limitations such as files exceeding 2.0 GB in size not being able to be uploaded through the web browser, only one user account for each side, etc.

The team did get through this by implementing PIX System[4], a convenient software for data management. “The PIX System allows access to a shared project file that all participants can access. Inside the shared project file, there were subdirectories for each interviewee, which included not only the two different angled shots, but any accompanying b-roll shots that would be relevant to the subject and their story”. The tagging function allowed the students from both sides to tag each file with keywords as notes, preventing the time-wasting process of having to opening each file to check the content. As a result, the PIX System became “essentially another extension of the visual storyboarding that was being accomplished by SAGE, except where SAGE allowed for streamlined group creative visual storyboarding during meeting time, the PIX System complemented the time outside of weekly meetings” (Figure 3.8).

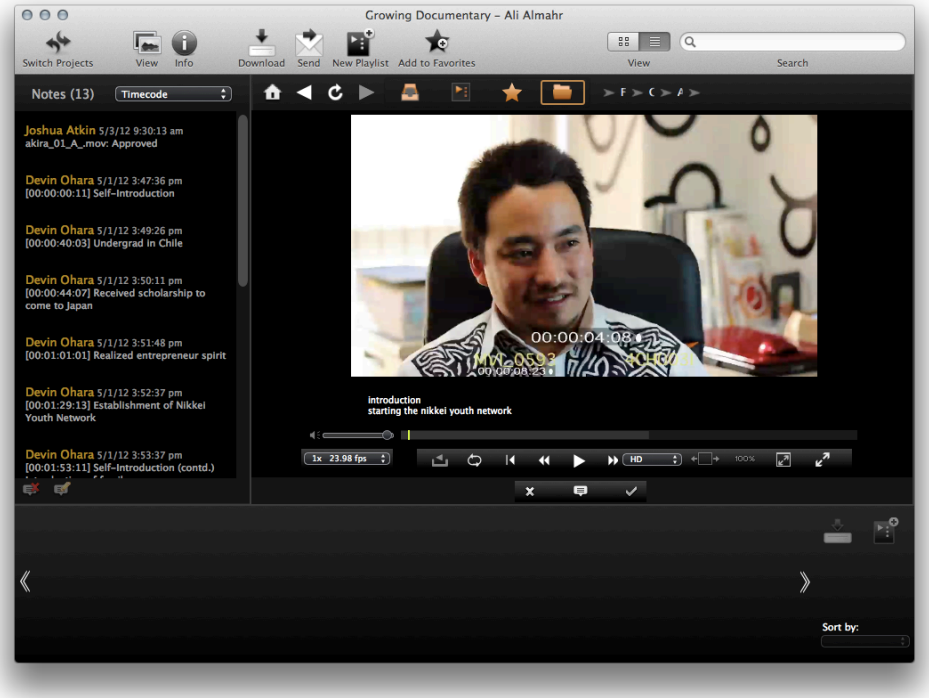

Figure 3.8: A screenshot from PIX System application, showing notes attached to the asset by users on the left side of the screen

With the help of PIX, the workflow for the production of “Places + Perspectives” was established. First, all footage taken from both sides are uploaded to the shared cloud folder. Obviously not all the footage will be used, so the selection process is undertaken with SAGE. KMD and UCSD held meetings using 4K cameras and NTT JPEG2K encoders[5] to send the images of each side with SAGE in the frame. This way, both sides were able to make sure what was being displayed on the remote SAGE Wall. Each side would display some of their footage on to their SAGE Wall to create a storyboard, discussing about which should be included in the final output, which would go well with others, etc (Figure 3.9). The files that were decided to be included in the final output would then be tagged on PIX, and other notes necessary were taken down and shared through Google Document. The overall workflow is depicted in Figure 3.10.

Figure 3.9: Storyboarding on SAGE Wall during meetings

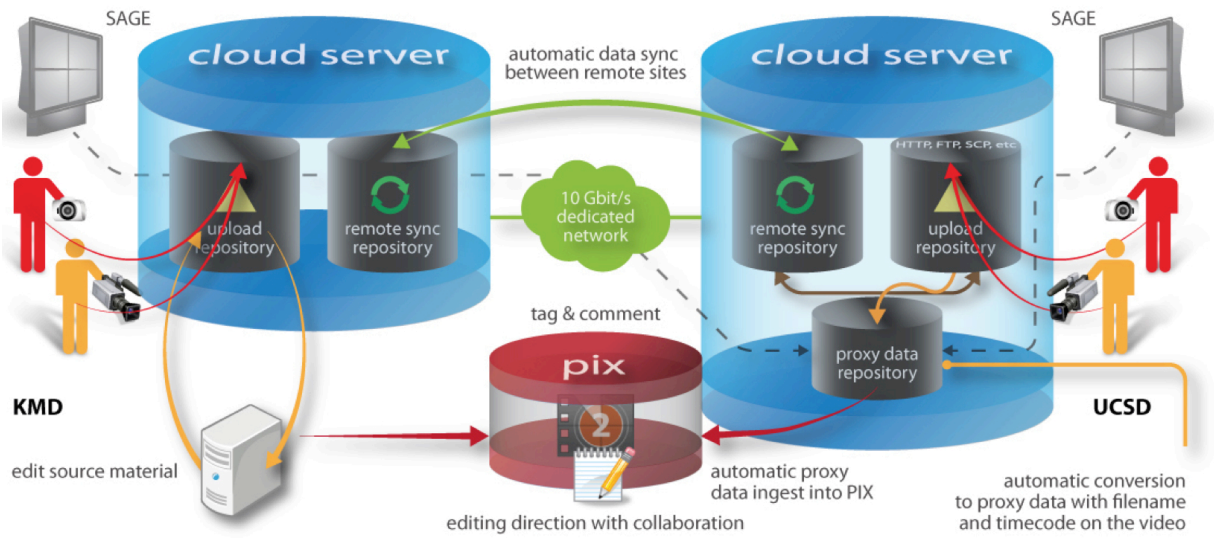

Figure 3.10: Workflow used for the production of “Places + Perspectives”

The refined editing stage is when the collected contents are integrated into one polished piece of work, but in the production of “Places + Perspectives”, most of the softwares available on both sides were catered to single users. Collaborative real-time editing was not possible and having two editors on the KMD and UCSD side posed some problems with finding a shared vision and also led to miscommunication.

3.2.3 User Interviews

User interviews were conducted with the production members from both sides to analyze the problems that were lying in the workflow of the production, which naturally led to the topic of “information sharing” and “technical ease of use”:

- Having different platforms makes it difficult to stay on top of all the information.
- The workflow alienated some of the members, making it hard for everyone to stay engaged. Keeping up with all the system is requiring a technical engagement that might push away potential collaborators.

- SAGE can not retrieve data from the server or other locations, so data has to be sent to SAGE.
- The lack of interactivity between SAGE and PIX was a disappointment and led to time loss.

SAGE does already have a “save/load session” function to keep track of which assets were displayed on the SAGE Wall during a session. However, as one student stated in the interview, “[it is impossible] to send saved sessions. It might be nice to create a playlist or a set of images and send the session to another place (that would also include any needed media)”.

The setup necessary for the meetings was another topic. The 4K cameras did make a contribution in the meetings, giving a detailed and clear image of the remote side and enabled users to recognize even a slight grin on one’s face. However, as it is state of the art technology, it did have negative effects at the same time. Fortunately for the UCSD side, there was the V-Room where all equipments would be kept in the same position. but for the KMD team, where a corner of a shared room was used for the weekly meetings, having to setup and clean up the equipments for each time was not the best meeting environment. When members with technical knowledge who were responsible of setting up were absent, the setup process did not go out smoothly, members from the UCSD side had to navigate them through Skype, which obviously lead to time loss and frustration in members because of it.

This is an inevitable topic when discussing about remote collaborative work, since the more secure the video transfer environment is, the better. However, this is partially a management problem, since the KMD side could have secured a space where they can keep the equipments in the same settings, or made documents to share the instructions of how to set up.

Since this paper is focusing on the features and functions of SAGE, it will omit reflections on it and will leave the improvements of it to outside sources.

3.3 Problems to be Resolved

The enormous amount of data collected from the preliminary test first needed to be organized to be utilized. As stated in the preceding section, some of the problems were out of the hands of SAGE (e.g. network environment), and the problems that would be possible to be solved by SAGE needed to be made clear On top of that, the data needed to be categorized to see what kind of problems were occurring in each stage of remote collaborative video production, which would lead to organizing what kind of functions would be necessary for each stage.

In order to do this, Ohara's six affecting factors in remote collaborative film making was used again. The last factor "Distribution and Expansion" was omitted since it matters more about the process after the final work is finished, which would differer depending on the genre of the film, production teams, etc, unlike the workflow of video production which is basically the same for all genres.

The problems found during the preliminary test were categorized according to the remaining five factors, as shown in Figure 3.11.

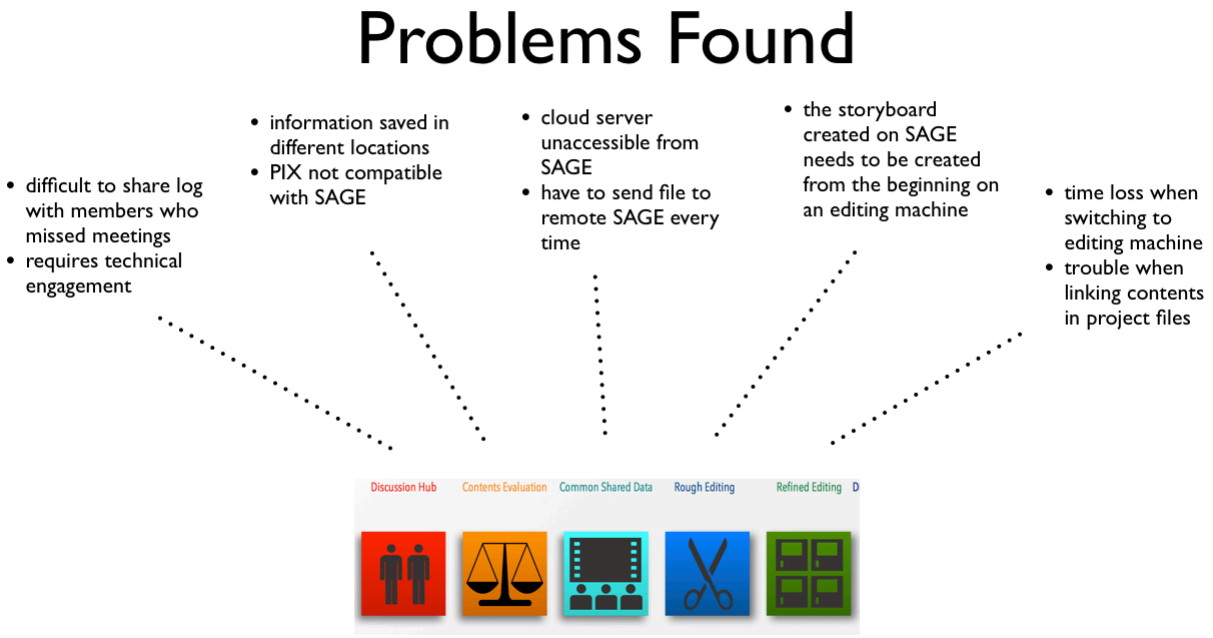

Figure 3.11: Problems found during preliminary test categorized into five affecting factors in remote collaborative film making

During the production, these problems lead to time loss, confusion, and frustration in users, which obviously would not have a good impact on the production, and needs to be solved for SAGE to become an efficient video production environment.

The problem that stood out most was the occurring during the Rough Editing stage, where a lot of users were pointing out how "storyboards created on SAGE needing to be recreated from the beginning when working on an editing machine" was a disappointment. Basically, the two teams would have good discussions to come up with a good story and a flow of video, but in order to compile them into a rough edit, users had to reconstruct that order from scratch on an editing machine.

It was clear that tremendous time was lost during the process of creating rough edits and evaluating them on the SAGE Wall. As sharing rough edits is a crucial part of video production, a system that would make the creation, distribution, and evaluation of them smooth is a high priority for making an effective tele-collaborative video production.

Notes

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[1] “Tele-Board” http://www.hpi.uni-potsdam.de/meinel/lehrstuhl/design_thinking/tele_board.html

[2] “Mezzanine™” http://www.oblong.com/mezzanine/

[3] “Places + Perspectives” https://vimeo.com/47917016

[4] “PIX System” http://www.pixsystem.com/

[5] “JPEG 2000 Real Time Codec” http://www.ntt-at.com/product/jpeg2000/

4. Proposed Implementation

From the analyzation of related works in Chapter 2 and observations made from the preliminary test in Chapter 3, a list of functions necessary and the workflow that can be accomplished with them that would enhance SAGE as an effective tele-collaborative video production environment is derived.

4.1 New Functions for SAGE

To see in which stage of remote collaborative video production will these new functions display its abilities, they are categorized into the six affecting factors in remote collaborative filmmaking created by Ohara;

Discussion Hub:

- stickies
- PDF output
- multi device interactions
- mirroring

Contents Evaluation:

- DAM software
- meta data input
- In / Out marks for videos

Common Shared Data:

- cloud server access from SAGE
- DAM software
  - synched meta data
  - automatic creation of proxies

Rough Editing:

- playlist output

Refined Editing:

- EDL output
- interaction pass through

The last factor, distribution and expansion, is more about after the completion of a production. By fulfilling this factor, “new seeds of collaboration are sewn, and the cycle of remote collaboration begins again”. This paper is focusing on enhancing the progress of the production itself, so functions for this factor will be omitted.

4.1.1 Discussion Hub

Students were frequently taking down notes during meetings to keep track of information such as file names and order of files during the production of “Places + Perspectives”. The method of these notes depended on the person and situation, causing inconsistency and confusion.

SAGE Wall currently only displays media files and shared desktops, but there are times where short memos become useful during meetings. By having a Stickies function, users will be able to input and display short memos on SAGE Walls. The user interface for this function would be a debatable topic, but since SAGE Pointer is already a convenient tool and was highly relied on during the production of “Places + Perspectives”, placing a text box in SAGE Pointer that would send text on the SAGE wall is a appropriate choice.

A PDF output function is also efficient in the discussion hub factor. As stated before, log taking for sharing information with members that couldn’t attend meetings was also a major topic in order to create a more efficient environment for remote collaboration. PDF output function valuable for keeping track of what was displayed on the SAGE Wall during meetings.

Combining this function with the Stickies function will enable users to output screenshots of SAGE Walls displaying media assets and stickies with text information, which can be used as annotations.

Depending on the number of people in the team, all members might not be able to interact with SAGE. During “Places + Perspectives”, although participating in the process by giving out opinions, some people weren’t able to actually experience the visual storyboarding process of moving around assets. Adding more screens on to the system might be an easy solution, but buying a 50 inch monitor might not be the most convenient choice for some people.

If users can access SAGE from devices other than computers, the possibilities awaiting expands too. The number of smartphone and tablet users have increased rapidly in recent years, are integrating them would spread the user experiences and actions possible within SAGE.

By having multi device interactions, people can interact with SAGE in much more ways, and use the space where SAGE is installed more dynamically. Considering a gigantic space like V-Room in UCSD, repetitively walking up to the SAGE Wall can become a more troublesome work then imagined. An example of an efficient way to use smart phones and tablets are with tagging and putting In/Out marks on video, which will be further discussed later on (Figure 4.1).

Figure 4.1: Designing different user interfaces per device to create more diverse interactions with SAGE

A mirroring function that would synchronize SAGE Walls should be implemented to keep the rhythm of discussions going. Like Tele-Board referred in Chapter 2, it would bring SAGE closer to a co-located setting that would enhance the creativity of users.

As well as a mirror function, access to SAGE Walls from PC/Mac should be implemented. Catching up with information after absence was a difficult task for users during "Places + Perspectives", narrowing down the key members of the production and losing potential collaborators.

Presently, SAGE only runs on a Linux system. Making the system completely compatible with Windows and MacOS X might require time, but a tool specifically for mirroring a SAGE session already running might lower the technical difficulty.

4.1.2 Contents Evaluation

PIX was a crucial factor for contents evaluation in "Places + Perspectives". SAGE was not able to cover the managing element involved in video production, where contents are repetitively evaluated and looked after. However, involving too many systems with different roles will bring confusion to users.

Implementation of a Digital Asset Management (DAM) software will be highly beneficial for SAGE. DAM consists of management tasks and decisions surrounding the ingestion, annotation, cataloguing, storage, retrieval and distribution of digital assets.

After conducting research on DAM softwares, the research team came to the open source DAM software "RAZUNA" [1]. Although RAZUNA and PIX are both external softwares with similar features, the advantage of RAZUNA is how it has an API developer guide open, which gives more freedom for users to customize its features and makes it more suitable to implement on to SAGE[2].

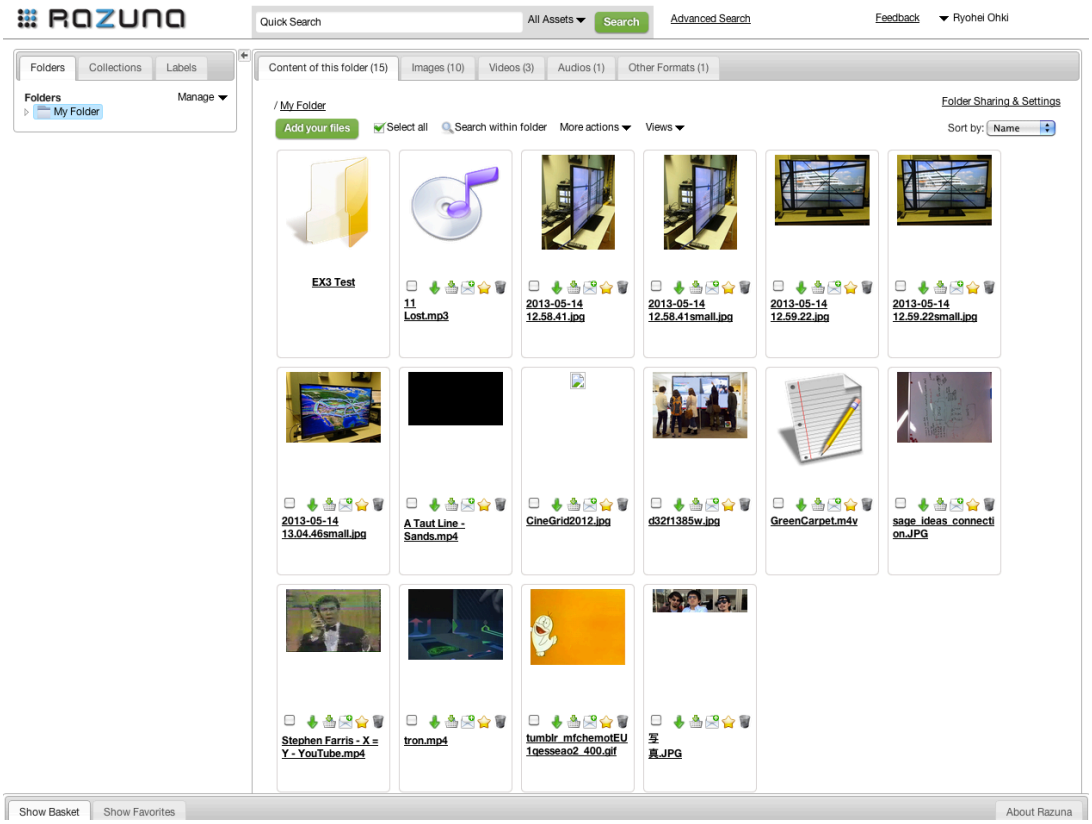

Figure 4.2: Web interface of RAZUNA implemented on PMP server

Once RAZUNA is installed on a cloud server, it can be accessed from a web browser as shown in Figure 4.2, but many ideas can be made true by making use of its API library.

Like PIX System, meta data and notes for individual files can be inputted from multiple users and be synchronized, files can be searched based on meta data, etc. By utilizing RAZUNA and its API, a meta data input function can be made, where users do not have to open their laptop and access an external system to tag videos with tags, but instead tag videos with meta data right on the SAGE Wall, as shown in Figure 4.3.

Figure 4.3: Meta data tagging user interface design, where users can swipe to tag

With this interface, meta data already registered can be displayed under assets when opened on the SAGE Wall. This way, keywords that arise during meetings can be tagged instantly to the files.

Videos usually have unnecessary contents in it, e.g. the shout of “action!” and “cut” by the director. There are also situations where a user wants to insert a different scene in the middle of a content (e.g. inserting b-roll footage in the middle of an interview, a technique often used in documentaries). This is why In / Out marks that designate the beginning and ending time of a video file, as shown in Figure 4.4, is important, which would increase the possibilities in visual storyboarding and allow users to have a better idea of how the story can progress.

Figure 4.4: Setting In / Out points on a video file

4.1.3 Common Shared Data

A cloud server has become an indispensable factor not just for remote collaborative video production, but even for global companies in the modern era. However, as seen during the production of “Places + Perspectives”, just establishing a cloud server does not help out fully. With the present settings, users will need to upload contents to SAGE and the cloud server individually in two different routes.

Enabling access to the cloud server from SAGE would definitely be necessary. If users are able to handle media files directly from the cloud server from the left hand side of the SAGE Wall (Figure 4.5), it can be combined with the meta data tagging interface stated before which would get the data automatically synchronized on the cloud server.

Shared data that was essential during “Places + Perspectives” was low resolution versions of contents. Although important when evaluating details in shots, raw data files are unnecessary when evaluating the continuity of contents, only resulting in latency of loading and transferring the files to the remote side. This is when the “workflow plugins” of RAZUNA demonstrates its power, where proxies of uploaded media files can be created automatically as a user designates, depending on what is necessary for that specific workflow.

When users are using SAGE for visual storyboarding and having a discussion, high resolution might not be the highest priority at sometimes (excluding a situation where the small details of a video is being examined). To keep the rhythm of the discussion going, the crucial element is to have the media assets smoothly and rapidly loaded up on the SAGE Wall, and a workflow plugin that would automatically create a lighter sized proxy of the original file would contribute tremendously for a workflow using SAGE.

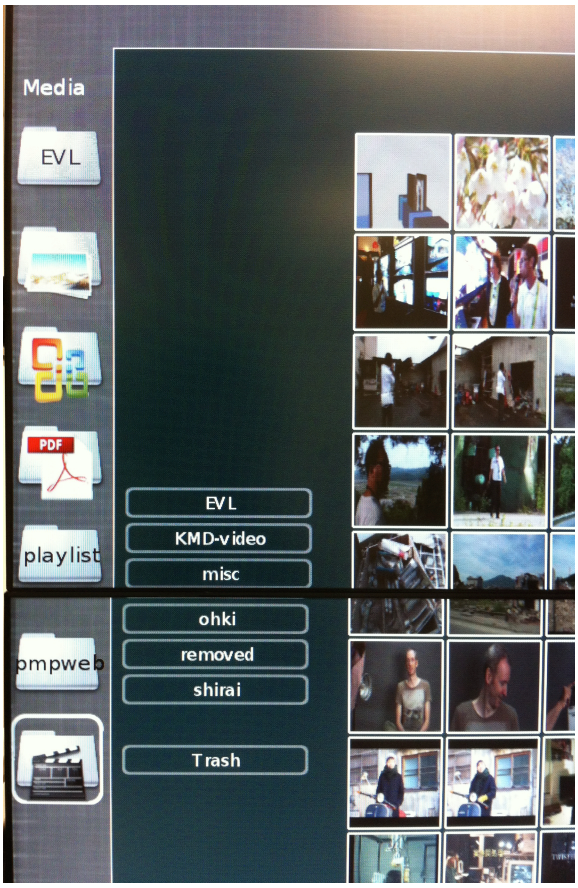

Figure 4.5: Clicking on the folders located on the left side of SAGE displays media files and subdirectories located under them

4.1.4 Rough Editing

Rough editing is the crucial process in video production that stimulates debates and leads to productive discussions. With the present settings of SAGE, video files opened are all automatically played and repeated individually, which is good as the first step of visual storyboarding, but not enough for a more deep discussion. The next step would be to evaluate how the contents flow in a specific order, i.e. evaluation of rough edits.

In the production of “Places + Perspectives”, after individual video files were evaluated and discussed during meetings and the teams got to a stage they would like to see the videos flow in order, editors had to note down the contents that the two teams had agreed to use. The editors would then run a NLE software and make the order created on the SAGE Wall again on it manually to make rough edits. Instead of making users take this time wasting process, SAGE should be able to complete this process on its system.

If SAGE can recognize multiple video files placed next to each other as a “timeline” and play them as a playlist in order, that would be a rough edit by itself and more deep discussions can take on from that point. This way, the flow of videos can be checked within minutes, tremendously saving time. An ideal interface would be one where the multiple video files get combined into one window (Figure 4.6).

Figure 4.6: Using playlist function to bring a visual storyboard into an order

4.1.5 Refined Editing

From the information gained after the preliminary test, it was clear that a massive time loss was occurring when trying to reflect the rough storyboards created on SAGE to a NLE software, which is necessary to create a refined edit to add more complex transactions and effects.

Adobe Premiere and Final Cut Pro, the two popular NLE softwares used heavily by professionals and amateurs, both are compatible with EDL (Edit Decision List) files. An EDL file would not only designate the order of video files and the In / Out marks of them, by

importing EDL files, a sequence is already organized on and editors can go straight to work for refined editing.

By having and EDL output function and using it after setting In / Out marks on videos, editors in charge of refined edit can smoothly get to their work, as shown in Figure 4.7.

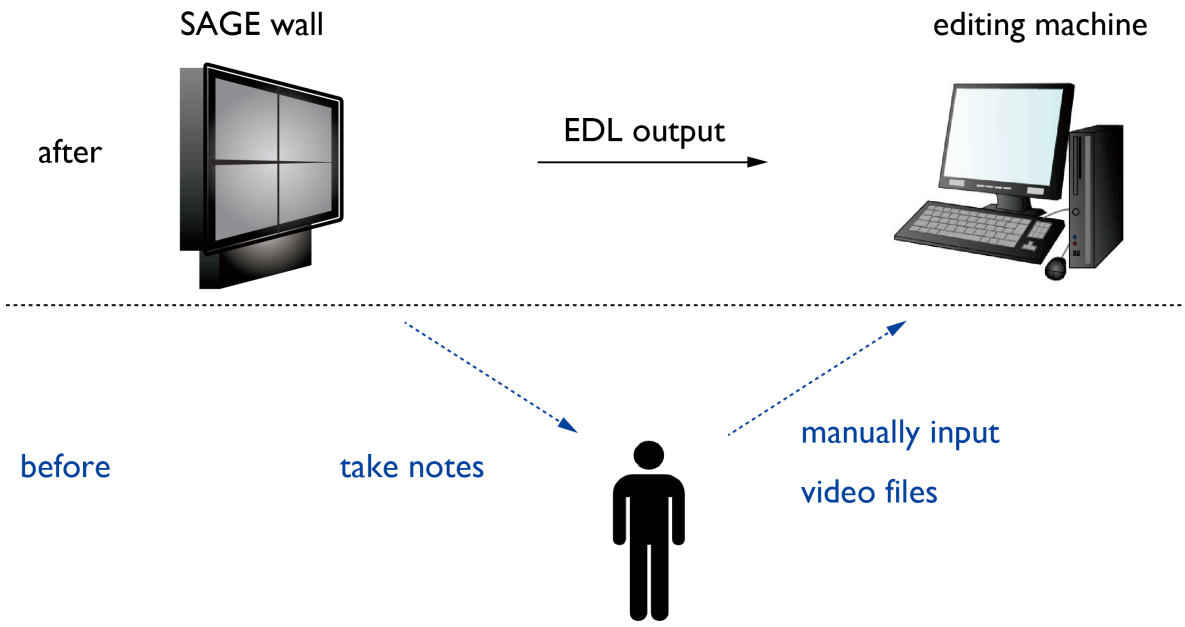

Figure 4.7: Workflow established with EDL output

It will be hard to implement all functions featured on a professional NLE software on SAGE. However, with the "share desktop" feature of SAGE Pointer, the workspace of an editor on an editing machine can be shared with other users. Instead of people gathering around behind an editor and giving opinions and orders to one single user to do all the work.

An "interaction pass-through" function helps out in this situation. Interaction with shared desktop through SAGE Pointer is made possible from this function, allowing other users to simultaneously operate a NLE software running on a machine.

4.2 New Workflow Using SAGE

The workflow that was used for the production of “Places + Perspectives” will dramatically change and become much more efficient with these functions.

The shooting and upload of data to the cloud server is the same as before. The huge difference is that the cloud server has RAZUNA installed on it. Proxies will be made for all uploaded files as specified on the workflow plugin, getting the base of the meeting ready at a very early stage.

When there is enough contents for the multiple teams to hold a meeting, they can gather in front of SAGE. Instead of uploading contents to the SAGE Wall with the SAGE Pointer, users can go ahead to start visual storyboarding by opening the cloud server folder accessible from the SAGE Wall.

Users can use stickies and meta data tagging to annotate video files and keep notes of them.

After spending enough time to evaluate each contents and the teams have an idea of which contents to use, they can compile them into a playlist and see how they integrate with each other and how the videos would flow when in order.

These processes will continue until they come to a stage where they want to see a rough edit. Users will set In / Out points for the videos and output them as an EDL file, which will get stored on the cloud server. The editor will access the cloud server on the editing machine and import the EDL file to a NLE software, which would bring the order of videos constructed on the SAGE Wall to the sequence panel with the In / Out points maintained (Figure 4.8).

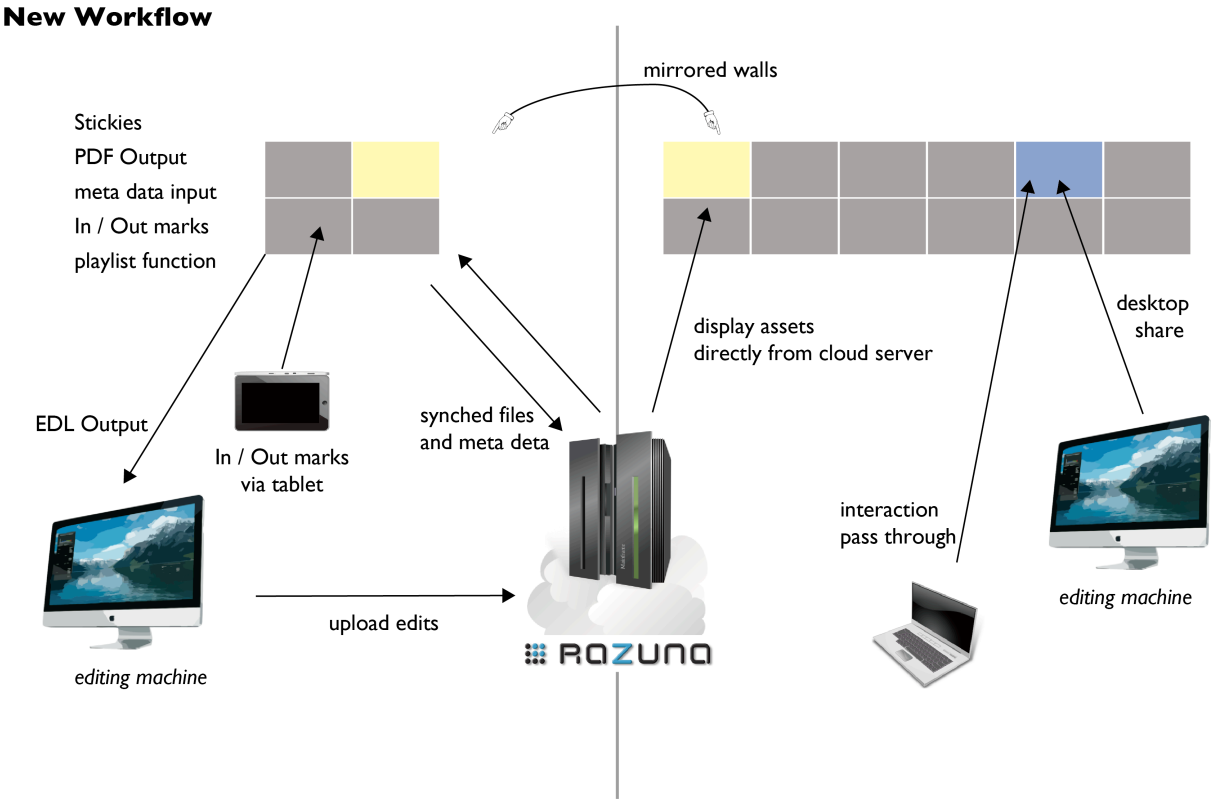

Figure 4.8: New workflow established with new functions

Since “Places + Perspectives” was a collaborative documentary, the workflow might not be exactly the same for other types of productions. However, the functions will be equally valuable.

Take Steven Spielberg’s example where he was monitoring the progress of the post-production for *Jurassic Park* from Poland. If his production team had the access to SAGE with the proposed implementations in this paper, he can open his laptop and access the SAGE Wall where the post-production of *Jurassic Park* is taking place. The editor can have its desktop shared on SAGE, where Spielberg can be watching all the actions the editors take. Instead of verbally explaining what to do to the editor, he can actually use interaction pass through to make some changes by himself.

Simultaneously, a rough edit of a different scene can be sent to his wall, where he can evaluate, put notes on it as meta data, change In / Out marks, etc.

4.3 Beginning of Implementation

Priorities were needed to be made beforehand to start the implementation of the functions. All functions are necessary to make SAGE an efficient environment for tele-collaborative video production, but based on the workflow of video production and the findings from the preliminary test, the author believes the storyboarding process is the most crucial part in video production, and the functions that would make that process executed smoother has a high priority.

During storyboarding, individual contents are evaluated to see which ones are usable, which ones are not. Then they are evaluated to see how they would integrate with each other, which leads to the creation of rough edits. The rough edits created are then brought to meetings, where discussions start based on them (Figure 4.9).

During the preliminary test, once both teams had started shooting, storyboarding took place literally during every meeting, showing the importance of this process. The more deep and beneficial discussion can take place here, the more the final piece can be refined.

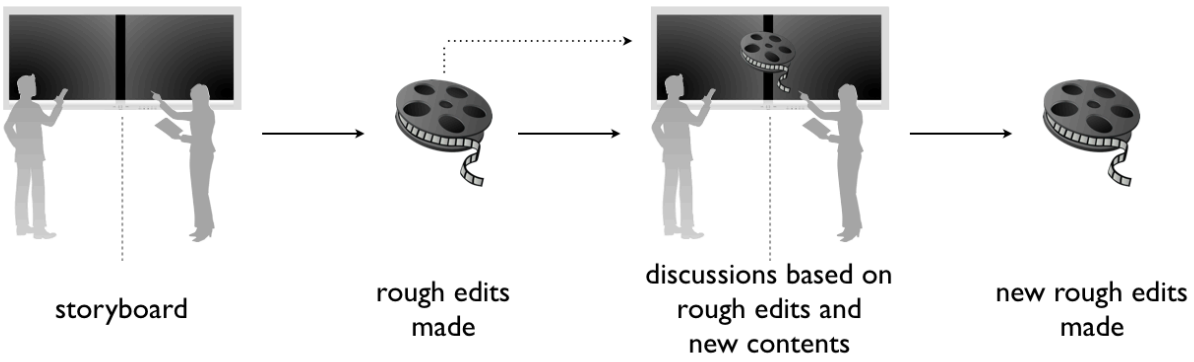

Figure 4.9: Discussions made from storyboarding and rough editing

Presently, mPlayer, the video player application installed on SAGE, plays all video files individually on repeat. This is good in a sense, since each content can be evaluated individually, but does not enable users to confirm the flow of the videos. During the preliminary test, users had to go to an editing machine and open an non-linear editing software, where they would create the order once again and would output it in one video file, to finally be able to evaluate a rough edit and see the flow of the videos.

Because of the importance of the rough editing stage, and because massive time loss was occurring during this crucial stage, the playlist output function became a high priority function to be implemented on SAGE.

The playlist output function is now successively implemented on SAGE and is a default function of SAGE installation kit from version 3.4.1. When the button placed on the right side of the SAGE Wall is pushed, the order of the video files displayed on the SAGE Wall are saved and extracted as a m3u format file.

Figure 4.10: Playlist output function and PDF output function implemented on right side of SAGE

The interaction pass through has also been installed, enabling the SAGE Pointer to access applications on remote machines. This function was successively demonstrated at the CineGrid[3] International Workshop 2012 on December 10, 2012 (Figure 4.10).

Figure 4.11: Interaction pass through in action; user A (above) is using his mouse cursor in San Diego to control Adobe Premiere running on user B's laptop (below), which is mirrored on the SAGE Wall in KMD

Research to add more features to SAGE is ongoing as of this writing. The effective use of RAZUNA is a key topic now. Also, a member of a hollywood film studio famous worldwide approached UCSD with interest of using SAGE as a tool in their production. The member stated how the EDL function would definitely be useful in their workflow, but he also stated the mirroring function would be necessary along with it for SAGE to become actually used in the production, making the implementation of it a high priority,

Notes

[1] "RAZUNA" http://www.razuna.org/

[2] “RAZUNA API Developer Guide” http://wiki.razuna.com/display/ecp/API+Developer+Guide

[3] “CineGrid” http://www.cinegrid.org/

5. Evaluation

5.1 Evaluation of Playlist Output Function

The playlist output function is now successively implemented on SAGE and is a default feature of the SAGE installation kit from version 3.4.1. To evaluate the effectiveness of this function, user tests and user interviews were conducted.

5.1.1 User Test

User tests were conducted to see how much time would get reduced by using the playlist output function. The participants all had experience in video production and usage in a NLE software. Using fifteen video files loaded on to SAGE beforehand, the users would:

1) reorder the files on the SAGE wall to create a story.

2) confirming the flow of the videos by creating the same order on a NLE software, installed on an editing machine located in the same room as SAGE is located.

3) confirming the flow of the videos using playlist output function.

Users will create the same order of video files on a NLE software by recording the filenames of the files used on the SAGE Wall, detecting those files on the cloud server from the editing machine, and finally importing them onto a NLE software to create the sequence. This was the procedure that was taken during the preliminary test, and was the only method where users can confirm the flow of videos.

The method to record the filenames was left to the users, which ended up as two users using their smartphones to take a photo of the SAGE Wall, one user using a pen and notebook to write down the filenames, as seen in Figure 5.1.

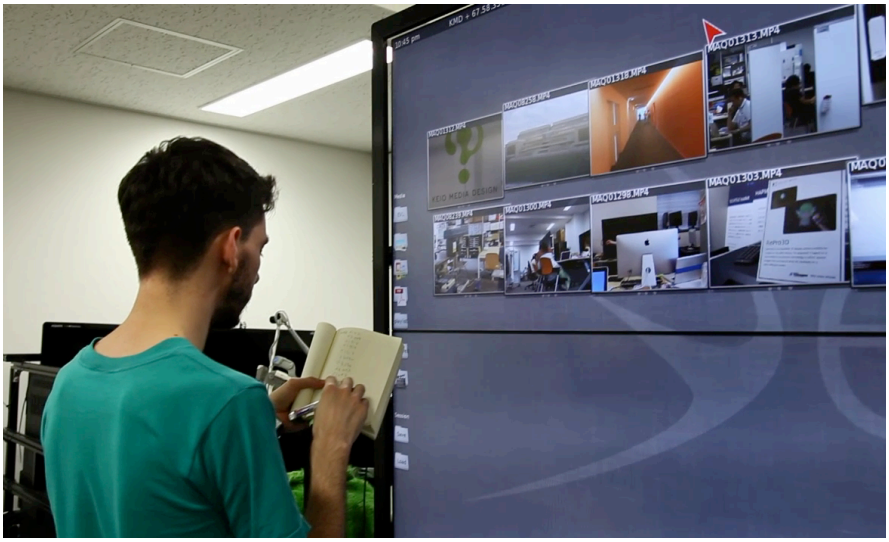

Figure 5.1: User using a pen and a notebook to record the filenames and the order of the storyboard created on the SAGE Wall

The results are shown in Table 5.1 and show how the playlist function dramatically shortens the time necessary to confirm the flow of the videos as a story.

Name	Time (mm:ss)	Method	Time (Playlist)
Y.T. ♀ (23)	04:53	photo (smartphone)	00:32
D.O. ♂ (24)	05:24	pen+paper	00:30
K.K. ♂ (26)	05:41	photo (smartphone)	00:33

Table 5.1: Results of user test comparing the time consumed for the two different methods

The time spent to create the storyboard on the SAGE Wall is not included in the results.

The average time it took for the users to recreate the orders on an editing machine was approximately five minutes, where the average time it took for the users to use the playlist output function and confirm the order of the videos as a playlist on a separate machine took only about thirty seconds.

Fifteen video files were used for this experiment, but obviously the increase in the number of video files would lead to an increase in the time it would take for a user to reconstruct the order on a sequence of an editing machine, since more files will be needed to be detected and imported. On the other hand, the playlist output function is not affected by the number of video files used, where users are able to confirm the flow of the contents by one push/click of a button placed on the right side of the SAGE Wall.

5.1.2 User Interview

User interviews were conducted on top of the user tests to gain opinions from users about 1) comparing the process of getting the same order on a NLE software with using the playlist output function, and 2) evaluating the videos as a playlist instead of evaluating the contents individually.

All users were impressed by how simple the process becomes and how much time is saved by using the playlist output function. One user stated how opening the NLE software itself was time consuming. Not just the fact that NLE softwares use more CPU and RAM than other softwares, when a new project file is opened on a NLE software, in this case Adobe Premiere Pro CS5, project settings and the directory settings are needed to be set. This not a

matter when using the playlist function, since users would only need to find and open the playlist file, which would stream the video files in the designated order on the default media player of the computer (e.g. Windows Media Player, iTunes).

The user test was conducted in one setting, but one user stated how this function would also become beneficial when a remote team is involved in the production. Since the video files will be shared on a cloud server, one team can send the other side a playlist file that can be opened in seconds, which is definitely time saving compared to the traditional methods.

In terms of evaluating the videos as a playlist compared to evaluating the videos individually, all three of the users stated how they were surprised at the playlist being longer than expected, or having videos with unnecessary scenes that weren't realized when displayed on the SAGE Wall. In order to create a good flow and rhythm of videos to convey the story better, taking away unnecessary sections in videos becomes the basic and core process for polishing the playlist. Because of this, having an In / Out mark setting function to set the beginning time and ending time of videos and combining the use of it with the playlist function would make the rough edit creation process on SAGE even more convenient, and is a high priority for future implementations.

5.2 Overall Evaluation

User interviews were conducted with two interviewees, one who has used SAGE before and one who has rich experience with video production and the film industry, to evaluate the proposed implementation of functions and the workflow that can be accomplished from them.

5.2.1 Interview 1

The first interview was with Devin Ohara, who participated in the production of "Places + Perspectives" as a director from the KMD side.

Ohara reflected how it became more and more difficult to create rough edits as the production of "Places + Perspectives" progressed. During the early stage, the number of contents was still low. An Adobe Premiere project file would be uploaded to the cloud server along with the contents, which enabled both sides to make quick changes easily. Some of the project files would still be linked up with the video files included in them as local files. (e.g. "User/Video/1.mp4" instead of "CloudServer/Video/1.mp4") This wasn't a huge problem at first, but as the number of contents increased, the project files began starting to handle 100 gigabytes of video files. "There was no possible way that we can download every single content and link everything manually on both sides, because it was changing so much, and there was no way to reflect the changes in real-time".

It ended up forcing the UCSD side to be in charge of all of the editing, where they would make rough edits, bring them to the tele-conference meetings and the KMD side will give out the opinions, killing the beneficial environment of visual storyboarding on SAGE and bringing it back to the traditional way of one person/team doing the editing, then getting feedback later. Ohara states it was actually worse because of the time difference between San Diego and Tokyo, causing a time loss from when the editing is finished to when it can get reviewed.

Because of this, Ohara states the playlist function and EDL function would have been very useful if it was present for the production of "Places + Perspectives". He reflects how starting up an NLE software itself was a time-loss. "It takes a while to stream and buffer on the NLE software. If you can cut down on that, take a good look on the contents, scrub

through it very fast and see exactly what you have to work with, then you can decide if its even worth bringing it into the conversation of editing".

Ohara sees the conveniency in using a media player playlist, where you can load a playlist on a media player to quickly go through the order of the video, see if it is good enough, then go on and load the same playlist file on an NLE software to make small changes. "You don't worry about transaction, it is about arranging things so that they have a resemblance of a story".

For the In / Out mark function, Ohara gives out a valuable opinion that should be reflected when implementing the function. He reflects how there an interviewees would give two or three good stories in one take, indicating how multiple In / Out points should be able to be specified for a single file.

Ohara now has a job where he shoots interviews news reports in Japan and creates rough edits to be checked by his bosses in the Hong Kong office. Now in a situation where he has lost the powerfulness of SAGE, he reflects how visual storyboarding on the SAGE Wall was a truly creative and time saving process, and how adding functions that would enable creation and evaluation of playlists would be "of course beneficial", making the experience of visual storyboarding conducted smoothly.

5.2.2 Interview 2

The second interview was with director and screenwriter Alec McAulay. With experience in the film industry and video production for more than twenty years, McAulay explained how the environment that can be accomplished with SAGE can be helpful in many ways.

Reflecting his experience in remote collaborative film production, he described how people have to be efficient when writing e-mails; words would be chosen very carefully to accurately convey ideas. On the other hand, face-to-face meetings are easy for people to wander off topic, but much more time-saving than writing e-mails. From this experience, McAulay says SAGE can get the best of both worlds, where people would feel as though they are in face-to-face environment, but feel the pressure of needing to be on task at the same time.

As a screenwriter, he also described how new plots can become possible with an environment like SAGE. "British TV companies tend to stay inside their city and always wants creators to come to them", where the traditional power relationship of producers standing above to give orders and make creators work is still present. McAulay says this "kills potential collaboration and ideas", so by having SAGE, he can collaborate with a British film company to work on a plot that he is currently working on, which takes on in the UK and Japan, without the necessity of him going to the UK.

As negative points, he points out how making a "too much perfect environment" might restrict creators from having casual conversations. If he had SAGE, he imagines himself to rather want to stay “on task” and not want to go into the small casual conversations, which would make a difference in terms of human relationships and would have an impact on the productivity of the production.

With his experience in film industry, McAulay points out something that only a person that has seen inside the film industry would notice. He pointed out the fact that how a producer being able to check the progress of the production from anywhere might have a negative effect too, since “with advanced technology, because we can be faster, it easy for a producer to assume that a creator ‘should be faster’.”

5.3 Reflections

The user test showed how the playlist function definitely does saves time, but interviews suggested that an In / Out mark function should be implemented to make an even more efficient use of the function in video production.

From the two interviews, one who participated in a production using SAGE and one who experience in the film industry and traditional tele-collaborative video production, many valuable opinions and feedbacks are gained.

As the proposed implementation is highly based on the preliminary test, it was natural for Ohara, who contributed highly in the production of “Places + Perspectives”, to feel that the functions would be effective in a tele-collaborative video production. From the opinions that he has given, it can be said that the proposed implementation of new functions and workflow will be efficient in a tele-collaborative video production environment.

Compared to Ohara that has given out opinions more based on the workflow, McAulay uses his insights gained from being involved in the film industry and shows his uncertainty of how an efficient environment might bring negative factors to the production scene.

6. Conclusion

6.1 Conclusion

This research has looked at the crucial elements in tele-collaborative video production, examined related works, and has conducted a preliminary test to observe the actions that would take place in a real-time remote collaborative video production using SAGE and the opinions that the participants would hold. The data collected has led to a proposed implementation of new functions and workflow for SAGE, which were evaluated by conducting interviews with Devin Ohara, who participated in the production of the preliminary test using SAGE, and Alec McAulay, a director and screenwriter with rich experience in video production and the film industry.

The preliminary test had proved how the process of creating rough edits and evaluating them together with a remote team was a crucial process to advance the production. At the same time it showed how time loss was occurring during it, where the users had to integrate external services to go through it that eventually led to another problem of managing information scattered in different locations.

The proposed implementation are based on the key factors that were derived from the examination on related works, actions observed during the plenary test, and user interviews conducted after the test. The functions are categorized into six major affecting factors of remote collaborative video production; some of the functions help discussions to be conducted in a more smooth form, some facilitate the creation of rough edits, which then leads to another discussion session to go on. The accumulation of this leads to the refined

editing stage, where users will be able to switch the main workspace from the SAGE Wall to an editing machine by using the EDL output function.

The creation of rough edits become is a crucial part of video production, and presently SAGE cannot support this work by itself. For this reason, the implement of the playlist output function became high priority. After it was successively implemented, the efficiency of it was evaluated, which showed how much time it can save to confirm videos as a playlist.

From the overall evaluation, it can be said that the proposed implementation of this paper will enhance SAGE as an efficient tele-collaborative video production environment, enabling users from multiple locations to interact with each other using traditional creative methods and conduct complex video production works at the same time. However, McAulay worries how the environment might aggravate the power relationship between producers and creators.

6.2 Future Works

At this stage, only few of the proposed functions have been implemented, and there is still work left to make SAGE an efficient environment for tele-collaborative video production.

The user test showed how the playlist output function definitely does saves time, but interviews suggested that an In / Out mark function should be implemented to make an even more efficient use of the function in video production. Because of this, he implementation of Novacut[1], a storyboarding and rough editing software, is ideal for the next step. (Figure 6.1) As it is UNIX based, Novacut has the high chance to get easily integrated on to SAGE, which

is also UNIX based. Novacut allows users to set In / Out marks for video files, and would be effective to be combinedly used with the playlist output function.

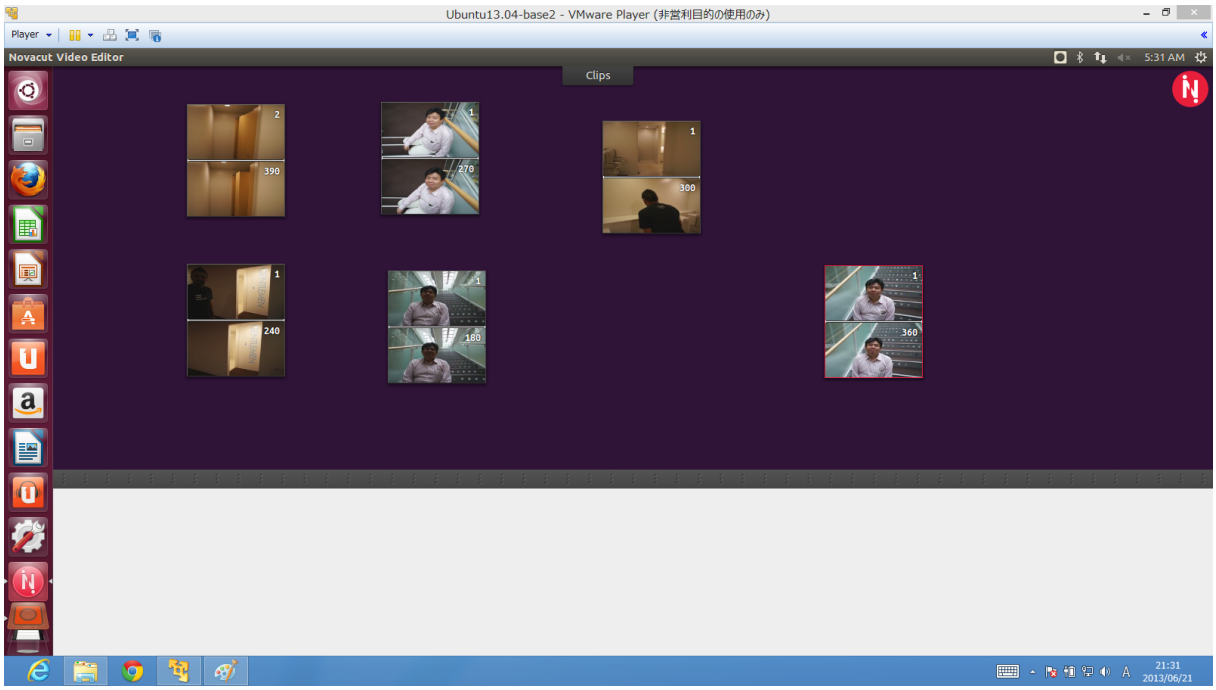

Figure 6.1: Screenshot of Novacut

Since SAGE is an open-source platform, many users can make efforts to implement the functions mentioned in this paper in different ways. Also, as technology advances, functions and workflows that can not be thought of as of this writing may become possible. That will not nullify the statement in this paper, since the key is not the specifications of the functions themselves, but to have functions that enhance the key works and aspects involved in remote collaborative video production, and to make people in different locations able to creatively interact and collaborate with each other.

Nevertheless, it is true that SAGE has many potentials for becoming an efficient environment to be used in tele-collaborative video production and can enhance the experience of people from different locations around the world working together to create video contents.

Notes

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[1] “Novacut” http://www.novacut.com/

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Appendix

A. Interview with Devin Ohara

Q. Can you please talk about the difficulties you had in the editing process of “Places + Perspectives”?

We started out with small amount of contents. During that time, we would upload the Adobe Premiere project files up to the server. In the beginning, it was quite successful because the amount of contents was not high. Plus, you have access to the project file itself, so changes can be made easily. But of course, the more contents you get, the less easier it becomes to manage them.

The project files at the end were dealing 100, 200 gigabytes of videos. Finding all of them, as well as the related audio track and synching them was basically impossible. Also, they are all linked to the directories of the PC of the local user who conducted the editing. There was no possible way that we can download every single content and link everything manually on both sides, because it was changing so much, and there was no way to reflect the changes in real-time. It ended up to forcing us to have UCSD edit the whole entire thing. We would just give opinions when tele-conferencing.

Q. So it was more like the traditional way of a director giving orders to an editor near the end?

I think it was even worse since we were not in the same place. An editor can usually be told directly by the director standing behind him, but since we had the spacing between us, that was impossible.

Q. How do you think EDL files and the DAM software can contribute to the workflow?

You don't have to even deal with local files. That already gets rid of the problems that we were dealing with, with having to manually link up files. There was no way to know where exactly the specific file was. That would have to be followed up by email, but the response would sometimes be 7 or 8 hours later because of the time difference. So, if there is a way that you can have everything up on the cloud and synch them, it would be a feasible solution and lot more effective.

Q. Speaking of Project Files, and since you guys used Adobe Premiere for the editing of “Places + Perspectives”, what do you think of Adobe Anywhere, and how would you compare that to this proposed implementation of SAGE?

The Adobe Anywhere would be a step up, it would be nice, but you are still faced with the old problems. You might make the end product a bit easier, depending on how many users can access one project file, but it still doesn't solve the problem of which contents are going to be used, how they are going to be arranged, etc. That's a conversation that needs to take place a long time before you even open up Premiere.

On the other hand, the SAGE system can cover the step beforehand at the same time. "These are the contents we want to use", “this might be a good arrangement of them”, "ok we're going to go with this", to "let's start editing them".

Q. When you say “the step before”, I think you are referring to the process of creating rough edits. How were rough edits created in “Places + Perspectives”?

I think there were two ways we did our rough edits.

In the very beginning, when we were trying to find out what kind of contents do we need, we kind of had like a design competition. We picked out three interviews, made a list of all files (audio and visual), each group talked it out to make a story, then compare them. Even when we did that, it still took a while to compile all of the contents. You would decide "I'm using this, “I'm using this", “I'm using this" on SAGE... then, "now, where is it?". (where is the file saved?)

Before we could have these kinds of meetings, we would have to decide beforehand. We would go to the cloud server, watch all those files separately, which isn't a problem, but it would be nice if you can just watch it all in one platform.

Q. How would having a playlist function affected the process?

It would be great because you can preview the contents first (on a media player), and then afterwards you can just say, "okay this is a good playlist, there's a lot of things I want to use, then go straight to Premiere. So I think there's a lot of positives of using this kind of playlist function and dealing with rough edits.

Just showing "we're gonna have this part" in a row, it won't be beautiful, but it will be convenient for discussion. You don't worry about transaction when rough editing, it is about arranging things so that they have a resemblance of a story.

Q. So you’re saying even just watching a simple playlist on a media player would be beneficial?

Of course. It takes a while to stream and buffer doing everything inside the editing software and is time loss. If you can cut down on that, first take a good lock on the contents, scrub through it very fast and see exactly what you have to work with, and then you can decide if its even worth bringing it into the conversation of editing.

Right now in my job, I shoot videos in Japan, and all the editing happens in Hong Kong. I shoot and edit first, then I send it to Hong Kong. The bad thing is, they don' get the contents until every things is set in stone. There is no way for them to preview the shots that I have, nor the audio. We have to use a separate scripting software to let them know exactly what kind of sound bytes, what kind of things the person is saying, so that they can work it into the script.

When you are interviewing people, you don't want to have two people facing the same direction, but sometimes we have interviews outside of Japan, where I wouldn't know which way the interviewees were facing. So, if they could look up a playlist, they could be like "the lighting is good, but the person is facing the wrong way." There is nothing they could do about it at that point, but at least they would know. Maybe they can find another person to give a similar clip who's facing the other way.

There is a bunch of beneficial data you can get from seeing the videos as a whole, in order.

Q. What about In / Out points?

One thing about In / Out points which is very important; if you are going to add them, make sure they are not finite. adding only one In and Out per clip.

Sometimes, someone might say three really good things during an interview. You have to make sure you can add them independent of the clip. It's the same for photo cropping, you can only get one. You want to make sure you can clip everything you need. Going back to the same video file a number of times would be very inconvenient.

At my work, I do not have something like SAGE, where you are working in real-time with a production staff and storyboarding. When you have contents on SAGE, you already kind of know to a certain extent, the in and out points, even if they are not specifically marked in your playlist, you have them in your mind. So, when you're watching it, you can see when the valuable contents are inside one video. Even if it is just a EDL playlist function where you have everything in order already, you storyboard on the wall, you have this clip first, then b-roll, then this clip...in these clips, you've already memo'd down the time, then you just edit out the parts that you don't need. Then you already have your basic rough edit within 30 minutes of compiling it from SAGE.

B. Interview with Alec McAulay

Q. Can you tell me about the tele-collaborative post-production that occurred in “Three Days in Kamakura”?

The music in Three Days in Kamakura is one of the most impactful elements of the film, and I never met Shawn (the composer) until the film was finished. I was back in the UK, and was looking for a composer, I met a Danish woman who knew a Canadian guy who was a composer in Tokyo, and put me in touch with him. If you think about it, the fact that he was in

Tokyo, we never met so it could have been anywhere in the world, but the fact that the story of the movie is set in Tokyo, he would have some empathy with the themes in the story.

I emailed him from the UK and told him about the project, he send me a link to his homepage where he had a lot of his music. There was nothing that I could use for the movie, but I liked what he had. I sent him a rough cut, he started putting pieces together, this might be good for this scene, this other one might be good for the other...

Q. Was taking post-production in two locations the initial plan?

The idea was to cut the film and do post-production in Tokyo. Then 3.11 happened, so I had to leave. I had a plan of getting a fine cut of the film over two weeks in Tokyo, I had a schedule. There was a American editor that I had met, we were all set to go, then 3.11 happened and everything stopped, I ended back in the UK with only the footage.

Q. How did the process go in the UK?

I recruited an editor through a Facebook friend, a guy I knew from Tokyo. His sister was in Glasgow and worked for a big post production company. She did the edit, then I would enter a post-production facility in Glasgow, “422.tv”, and then got Shawn to look at the edits as we were doing them. We fine cut the music to the film, so we didn't have the music fade out. Every time we made a new edit, for example shave two seconds off of a shot, I had to go back to Shawn and ask "You are going to have to take 2 seconds off this music".

Q. All of this was e-mail based?

1It was all e-mail. We never Skyped, we never even phoned once, it was all e-mail.

Q. Was there any disappointment or frustration that occurred because of this process?

In terms of the music and the relationship with Shawn, I don't think so. I can see in other relationships, but in terms of this one, no, because I think you had to be very efficient with your WRITTEN communication. You can sit down and have a 3-hour meeting and say "that was a great", but unless you've been very business like and you've taken notes and you've both agreed on the notes, you can actually come away with a very different interpretation. I have been in that situation. Where as with Shawn, because it was all written down, it was all clear.

However, when I wanted him to write a piece for the firework sequence, I said it has to be "hopeful but lacking resolution".

Q. So you had to give out vague words to convey what you wanted, didn't you?

Yes. I remember hitting "send" and thinking, "I don't know what that means myself". But he gave a reply saying "here's what I have come up with", and that was it. It was fantastic. Where as if we had sat down and had a conversation, we might have actually talked that idea to death.

In terms of efficiency, it very much depends on the personality I think.

Maybe face to face communication isn't as efficient, because you don't have to think about your messages, where as if an email, I have to think "this is what I want to say", write AND edit it, which doesn't happen in verbal communication.

Q. It's interesting that you say that, how there are negative points in face-to-face communication.

Absolutely, unless you're very business like. But that doesn't happen a lot in film.

In Britain, they do very much want to sit down and talk to you, but they want you to come to London, they don't want to move out. It made me realize how difficult is trying to sell my projects to Britain video creators, structured as UK-Japan collaborations.

The argument is, producers are trying to save cost, because can they go back to their homes at night instead of hotels. It's a cost thing.

Q. Any thoughts when comparing that kind of traditional power relationship between producers and creators with remote collaborative environment?

I was forced to do those collaborations for “Three Days in Kamakura”. Yes, I could have found a composer in the UK, but the material demanded a composer who has knowledge of the Japanese setting. It wouldn't have been my first choice, but the 3.11 emergency forced me that situation, and now having gone through it, IT WOULD be my first choice. I don't think you need to sit down and meet as much as people think they do. It's time-saving and more efficient.

Q. But as you said, it really depends on the personality. Luckily Shawn got the idea got the idea from the vague words used in the e-mail, but what if the composer was someone who interprets your words completely differently?

I think the default assumption is that sitting down face-to-face will somehow create the magic better than an e-mail or Skype meeting. If you have that hypothetical situation where you have a piece of music and it's not working, and you agree to go away and lock yourselves in a room for 3 hours, that will come out and that is the best way to do it, I don't think that assumption is valid anymore.

You can question it because, if I'm the creative director, and I have to articulate what it is I want, in the room I can just say "Yea, you know, I don't know what I want but I'll know when I hear it", but on an e-mail, that's just not gonna be acceptable. I realized I just couldn't say "give me something good".

Q. More than e-mail, I want to introduce you SAGE, which has the potential to become an efficient remote collaborative environment for video production. What do you think about this?

Having to be efficient and having to be urgent in email, where as you can be wandering and off topic if your sitting down face to face, I think you can get the best of both worlds with this. With all the equipments, with everyone staying on task, I'm not gonna say, "I'm gonna go get a coffee" or "look at this cat on YouTube", I'm not gonna do that. That happens a lot (during face-to-face meetings).

In terms of efficiency, you can take the best of both worlds. It's synchronous communication, but through this traditionally asynchronous format, so you're still in a asynchronous mind set as you're doing it, perhaps.

Q. What do you think about the workflow that SAGE might able to accomplish with my proposed implementation of functions?

In terms of creative producers having a impact on the project, the fact that they can see the dailies in real time no matter where they are is definitely advantageous.

Maybe you've got three days on a location, you shoot the first day, the thing that you shoot on the first day is something not acceptable by the producer, who is in Panama. There watching this with you and you can have the discussion, where as in the past maybe maybe they would be watching it in a different time, e-mailing you but not being able to catch you... it's a time saving thing.

Q: Will you be willing to use this environment?

With this environment, I can work on the plot that I am working on right now, which takes place in both Japan and the UK. As I said, Britain production companies want the creators to come to them, but I'm in Japan now and that would be too much for me. With this, collaborate to work together, even staying in our areas.

Also, What I think I would gain from it is, the flexibility of being able to access their work on my own time, not being tied to a schedule.

I had to go into 422.tv from 9AM to 5PM, sit with editors and go through it, where as with this environment, I can sit in my own living room and do this at my own time.

I'm gonna contradict myself, what you're gonna lose from this is, you do want to establish that human connection a little bit. I do want to have that time where we're sitting having our sandwiches and we talk about our kids.

Q: Being able to talk to your co-walkers without feeling pressure?

Yes. I also remember Romano, who did color-correction, was using this software that I didn't know. I was saying him "what is this software you're using?" and he teached me a lot. That was a kind of small talk, but it was kind of related to what we were doing. I wanted to know for the future. If I was in that tele-collaborative environment and being "on task", I might not want to go into that small talk area. Those kind of happy accents, side things, might not come out as much.